REPORT

OF THE

SIXTH MEETING

OF THE

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

HELD AT

BRISBANE, QUEENSLAND, JANUARY, 1895.

Sole Editor:

JOHN SHIRLEY, B. Sc.

(DISTRICT INSPECTOR OF SCHOOLS, QUEENSLAND.)

PUBLISHED BY THE ASSOCIATION.

PERMANENT OFFICE OF THE ASSOCIATION:

THE UNIVERSITY, GLEBE, SYDNEY, NEW SOUTH WALES.

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OF

THE SECOND VOLUME

10. The Council shall meet only during the Annual Meeting of the Association, and during that period shall be called together at least twice.

LOCAL COMMITTEES.

11. In the intervals between the sessions of the Association its affairs shall be managed in the various colonies by Local Committees. The Local Committee of each colony shall consist of the members of Council resident in that colony.

OFFICERS.

12. The President, five Vice-Presidents (elected from amongst former Presidents), a General Treasurer, one or more General Secretaries and Local Secretaries shall be appointed annually by the Council.

13. The Governor of the colony in which the Session is held shall be *ex officio* a Vice-President.

RECEPTION COMMITTEE.

14. The Local Committee of the colony in which the Session is to be held shall form a Reception Committee to assist in making arrangements for the reception and entertainment of the visitors. This Committee shall have power to add to its number.

OFFICE.

15. The permanent office of the Association shall be in Sydney.

MONEY AFFAIRS OF THE ASSOCIATION.

16. The financial year shall end on the 30th June.

17. All sums received for life subscriptions and for entrance fees shall be invested in the names of three Trustees appointed by the Council, and the interest only arising from such investment shall be applied to the uses of the Association.

18. The subscriptions shall be collected by the Local Secretary in each colony, and by him forwarded to the General Treasurer.

19. The Local Committees shall not have power to expend money without the authority of the Council, with the exception of the Local Committee of the colony in which the next ensuing Session is to be held, which shall have power to expend money collected or otherwise obtained in that colony. Such disbursements shall be audited, and the balance-sheet and the surplus funds forwarded to the General Treasurer.

20. All cheques shall be signed either by the General Treasurer and the General Secretary, or by the Local Treasurer and the Secretary of the colony in which the ensuing Session is to be held.

21. Whenever the balance in the hands of the Banker shall exceed the sum requisite for the probable or current expenses of the Association, the Council shall invest the excess in the names of the Trustees.

22. The whole of the accounts of the Association—*i.e.*, the local as well as the general accounts—shall be audited annually by two Auditors appointed by the Council; and the balance-sheet shall be submitted to the Council at its first meeting thereafter.

MONEY GRANTS.

23. Committees and individuals to whom grants of money have been entrusted are required to present to the following meeting a report of the progress which has been made, together with a statement of the sums which have been expended. Any balance shall be returned to the General Treasurer.

24. In each Committee the Secretary is the only person entitled to call on the Treasurer for such portions of the sums granted as may from time to time be required.

25. In grants of money to committees, or to individuals, the Association does not contemplate the payment of personal expenses to the members or to the individual.

SECTIONS OF THE ASSOCIATION.

26. The following sections shall be constituted :—

A.—Astronomy, Mathematics, and Physics.
B.—Chemistry.
C.—Geology and Mineralogy.
D.—Biology.
E.—Geography.
F.—Ethnology and Anthropology.
G.—Economic Science and Agriculture.
H.—Engineering and Architecture.
I.—Sanitary Science and Hygiene.
J.—Mental Science and Education.

SECTIONAL COMMITTEES.

27. The Presidents, Vice-Presidents, and Secretaries of the several sections shall be nominated by the Local Committee of the colony in which the next ensuing Session of the Association is to be held, and shall have power to act until their election is confirmed by the Council. From the time of their nomination, which shall take place as soon as possible after the Session of the Association, they shall be regarded as an Organising Committee, for the purpose of obtaining information upon papers likely to be submitted to the sections, and for the general furtherance of the work of the Sectional Committees. The sectional Presidents of former years shall be *ex officio* members of the Organising Committees.

28. The Sectional Committees shall have power to add to their number.

29. The Committees for the several sections shall determine the acceptance of papers before the beginning of the Session. It is therefore desirable, in order to give an opportunity to the Committees of doing justice to the several communications, that each author should prepare an abstract of his paper, of a length suitable for insertion in the published transactions of the Association, and that he should send it, together with the original paper, to the Secretary of the section before which it is to be read, so that it may reach him at least a fortnight before the Session.

30. Members may communicate to the sections the papers of non-members.

31. The author of any paper is at liberty to reserve his right of property therein.

32. The Sectional Committees shall meet at 2 p.m. on the first day of the Session in the rooms of their respective sections, and prepare the programmes for their sections and forward the same to the General Secretaries for publication.

33. On the second and following days the Sectional Committees shall meet at 10 a.m.

34. No report, paper, or abstract shall be inserted in the annual volume unless it be handed to the Secretary before the conclusion of the Session.

35. The Sectional Committees shall report to the Publication Committee what papers it is thought advisable to print.

36. They shall also take into consideration any suggestions which may be offered for the advancement of Science.

RESEARCH COMMITTEES

37. In recommending the appointment of Research Committees all members of such Committees shall be named, and one of them who has notified his willingness to accept the office shall be appointed to act as Secretary. The number of members appointed to serve on a Research Committee should be as small as is consistent with its efficient working. Individuals may be recommended to make reports.

38. All recommendations adopted by Sectional Committees shall be forwarded without delay to the Recommendation Committee; unless this is done the recommendation cannot be considered by the Council.

39. The President of each Section shall take the chair and proceed with the business of the Section at 11 a.m. precisely. In the middle of the day an adjournment for luncheon shall be made; and at 4 p.m. the sections shall close.

40. At the close of each meeting the Sectional Secretaries shall correct, on a copy of the official journal, the lists of papers which have been read, and add to them those appointed to be read on the next day, and send the same to the General Secretaries for printing.

RECOMMENDATION COMMITTEE.

41. The Council at its first meeting in each year shall appoint a Committee of Recommendations to receive and consider the reports of the Research Committees appointed at the last session, and the recommendations from Sectional Committees. The Recommendation Committee shall also report to the Council, at a subsequent meeting, the measures which they would advise to be adopted for the advancement of Science.

42. All proposals for the appointment of Research Committees and for grants of money must be sent in through the Recommendation Committee.

PUBLICATION COMMITTEE.

43. The Council shall each year elect a Publication Committee, which shall receive the recommendation of the Sectional Committees with regard to publication of papers, and decide finally upon the matter to be printed in the volume of Transactions.

ALTERATION OF RULES.

44. No alteration of the Rules shall be made unless due notice of all such additions or alterations shall have been given at one Annual Meeting and carried at a subsequent Annual Meeting of the Council.

OFFICERS AND COUNCIL, 1895.

President:

Hon. A. C. Gregory, C.M.G., M.L.C.

Vice-Presidents:

His Excellency Sir Henry Wylie Norman, G.C.B., G.C.M.G., C.I.E.; H. C. Russell, C.M.G., B.A., F.R.S., F.R.A.S.; Baron F. v. Mueller, K.C.M.G., Ph.D., F.R.S., &c.; Sir James Hector, K.C.M.G., M.D., F.R.S.; Professor Ralph Tate, F.G.S., F.L.S.

Permanent Secretary:

Professor A. Liversidge, M.A., F.R.S.

Past General Secretaries:

Professor W. Baldwin Spencer, M.A.; Captain F. W. Hutton, F.R.S.; Alexander Morton, F.L.S.; Professor Rennie, M.A., D.Sc.; Professor Bragg, M.A.

General Treasurer:

H. C. Russell, C.M.G., B.A., F.R.S., F.R.A.S.

Local Treasurer:

Hon. Albert Norton, M.L.C., Union Trustee Company, Creek street, Brisbane.

General Secretaries:

John Shirley, B.Sc., District Inspector of Schools; C. W. De Vis, M.A., Curator, Queensland Museum.

Local Secretaries:

E. F. J. Love, M.A., Queen's College, Melbourne; Professor Parker, B.Sc., F.R.S., C.M.Z.S., Otago University, Dunedin, N.Z.; Alexander Morton, F.L.S., Tasmanian Museum, Hobart; Professors Rennie and Bragg, Adelaide.

Ordinary Members of Council:

The Council consists of the following:—(1.) Present and former Presidents, Vice-Presidents, Treasurers, and Secretaries of the Association; and present and former Presidents, Vice-Presidents, and Secretaries of the Sections. (2.) Authors of Reports or of Papers published *in extenso* in the Annual Reports of the Association.

Auditors:

R. Teece, F.I.A. | R. A. Dallen.

Trustees:

H. C. Russell, C.M.G., B.A., F.R.S.
R. L. J. Ellery, F.R.S.
Professor Liversidge, M.A., F.R.S.

Publication Committee:

Hon. A. Norton, M.L.C.
Reginald H. Roe, M.A.
Robert L. Jack, F.G.S., F.R.G.S.
The President
F. M. Bailey, F.L.S.
George Watkins
J. P. Thomson, F.R.S.G.S.
The General Secretaries.

PRESIDENTS, VICE-PRESIDENTS, and SECRETARIES of SECTIONS at the BRISBANE MEETING, 1895.

—	Presidents.	Vice-Presidents.	Secretaries.
Section A.—Astronomy, Mathematics, and Physics	Alexander McAulay, M.A. ...	Clement Wragge, F.R.M.S. C. H. Hodges, M.A. J. E. Davidson, B.A.	J. P. Thomson, F.R.S.G.S.
Section B.—Chemistry	J. H. Maiden, F.L.S.	A. S. Denham. George H. Irvine. J. B. Henderson.	George Watkins.
Section C.—Geology and Mineralogy	Professor T. W. E. David, B.A., F.G.S.	William Fryar. Ernest Lidgey. W. H. Rands.	W. A. Hargreaves, M.A., B.C.E.
Section D.—Biology	Professor A. Dendy, D.Sc., F.L.S.	F. M. Bailey, F.L.S. W. McIlwraith.	J. F. Bailey and J. H. Simmonds.
Section E.—Geography	Baron F. v. Mueller, K.C.M.G., Ph. D., F.R.S.	J. N. Waugh, M.D. D. S. Thistlethwaite, C.E. Ernest Favenc.	Major A. J. Boyd.
Section F.—Ethnology and Anthropology ...	Thomas Worsnop	Joseph Lauterer, M.D. Thomas Petrie.	Archibald Meston.
Section G.—Economic Science and Agriculture	Professor W. Scott, M.A. ...	Sir John Madden, Kt., C.J. Hon. A. J. Thynne, M.L.C. John Cran. J. H. McConnel. Peter McLean. Alexander Paterson.	L. E. Groom, M.A., LL.M., and Wm. Soutter.
Section H.—Engineering and Architecture ...	James Fincham, M.Ins.C.E. ...	H. C. Stanley, M.I.C.E. A. B. Brady, A.M.I.C.E. Richard Gailey.	Claude W. Chambers.
Section I.—Sanitary Science and Hygiene ...	J. W. Springthorpe, M.A., M.D., M.R.C.S.	J. H. Little, M.B. A. E. Salter, M.B. F. H. Vivian Voss, F.R.C.S.	David Hardie, M.D.
Section J.—Mental Science and Education ...	Professor F. Anderson, M.A. ...	Hon. T. J. Byrnes, M.L.A. R. H. Roe, M.A. J. Brunton Stephens. Thos. Bradbury.	J. L. Woolcock, B.A., and J. J. Dempsey.

GENERAL PROGRAMME FOR THE MEETING.

Friday, January 11.

2 p.m.—Sectional Committees meet.

4 p.m.—Excursion to White's Hill.

8 p.m.—Lecture by H. C. Russell, B.A., F.R.S., C.M.G., in the Centennial Hall, on "Star Depths."

Saturday, January 12.

10 a.m.—Sectional Committees meet.

11 a.m.—First Meeting of General Council.

3.30 p.m.—Reception by His Excellency the Governor at Government House.

7.30 p.m.—President's Reception in the Centennial Hall.

8 p.m.—Inaugural Meeting and President's Address.

Monday, January 14.

10 a.m.—Sectional Committees meet.

Presidential Addresses will be delivered as follow:—

10.30 a.m.—Section A.—Alex. McAulay, M.A.
Section B.—J. H. Maiden, F.L.S.
Section C.—Professor David, B.A., F.G.S.

11.30 a.m.—Section D.—Professor Dendy, D.Sc.
Section E.—Baron F. von Mueller, K.C.M.G., F.R.S., &c.
Section F.—Thomas Worsnop, Esq.

2 p.m.—Section G.—Professor W. Scott, M.A.
Section H.—James Fincham, M. Inst. C.E.

3 p.m.—Section I.—Dr. J. W. Springthorpe.
Section J.—Professor F. Anderson, M.A.

Tuesday, January 15.

10 a.m.—Sectional Committees meet.

11 a.m. }
2 p.m. } Sections meet for work.

4 p.m.—River Excursion to Indooroopilly Bridge.

8 p.m.—Medical and Scientific Conversazione in the Centennial Hall.

Wednesday, January 16.

10 a.m.—Sectional Committees meet.

11 a.m. }
2 p.m. } Sections meet for work.

4 p.m.—Excursion to One-tree Hill.

Thursday, January 17.

10 a.m.—Sectional Committees meet.

11 a.m. }
2 p.m. } Sections meet for work.

4 p.m.—River Excursion to Lytton Fort.

8 p.m.—Concert by Liedertafel Society.

Friday, January 18.

10 a.m.—Sectional Committees meet.

11 a.m.—Sections meet for work.

2 p.m.—Meeting of General Council.

4 p.m.—Excursion to Enoggera Waterworks.

8 p.m.—Lecture by Dr. N. Cobb, Ph.D., in the Centennial Hall, entitled "Looking Forward."

Saturday, January 19.

Excursion to Bay and Islands.

Monday and Tuesday, January 21 *and* 22.

Excursion to Tambourine Mountain.

Wednesday, January 23.

Excursions to—

(1) Toowoomba and the Darling Downs;
(2) Eumundi, Gympie, and Bundaberg.

N.B.—Luncheon provided from Saturday, 12th January, to Friday, 18th January, inclusive, in the Central Hall, Girls' Grammar School.

MEETING OF THE GENERAL COUNCIL.

Saturday, 12th January, 1895.

EXTRACTS FROM THE MINUTES.

The first meeting of the General Council in Brisbane was held at the Boys' Grammar School, at 11 a.m. Mr. H. C. Russell, C.M.G., presided, and was supported by His Excellency Sir Henry W. Norman, G.C.B., &c.

Mr. Russell said that urgent matters had detained Professor Tate in Adelaide, and he was consequently unable to be present. He (Mr. Russell) had therefore been asked to preside at the meeting as one of the Vice-Presidents.

Professor Kernot proposed that the action of the Local Committee in making arrangements be confirmed, and that the election of sectional officers be also confirmed.

Professor Rennie, in seconding the motion, expressed his appreciation of the labour and care the Local Committee, and especially Mr. Shirley, had evinced in making preparations for the meeting. He had to express his gratification at the completeness of all the arrangements for the proper conduct of the meeting, and especially of those for the comfort of members who had come from a distance. The motion was agreed to.

Mr. A. C. Macdonald moved, and Mr. Augustus Simson seconded, the adoption of the General Treasurer's statement and balance-sheets. The motion was carried.

Mr. Russell, Hon. Treasurer, said the balance-sheets showed a highly satisfactory condition of affairs.

Hon. A. Norton, M.L.C., Local Treasurer, said the Parliament of Queensland had voted £500 towards the expenses of the Brisbane meeting. Sufficient money had been received locally, by way of subscription, to provide for ordinary expenses that might have to be met.

Sir Henry Norman proposed that Professor Liversidge be President for the Sydney meeting. As all were aware, Professor Liversidge was one of the founders of the Association; he had eminent qualifications for the office of President

Professor Rennie, in seconding the motion, said that those who had worked with Professor Liversidge in the serious business of the Association knew the amount of labour and time he had devoted to its interests. The motion was carried by acclamation.

Professor Liversidge said it was gratifying to him to find that what he had done for the Association was so thoroughly appreciated. Under the circumstances he thought it would be very ungracious on his part to refuse; and he had therefore much pleasure in accepting the further mark of honour they had conferred on him.

Mr. Russell was re-elected General Treasurer, on the motion of Mr. SHIRLEY, seconded by Hon. A. NORTON.

The following were elected Local Secretaries, on the motion of Hon. A. NORTON, seconded by Hon. A. C. GREGORY:—Mr. John Shirley, Queensland; Mr. E. F. J. Love, Victoria; Professors Rennie and Bragg, South Australia; Mr. A. Morton, Tasmania; and Professor Parker, New Zealand.

The following were also elected:—

Recommendation Committee:—The President, General Secretaries, Treasurers, Professors Rennie and Kernot, and Mr. J. H. Maiden.

Publication Committee:—Messrs. F. M. Bailey, C. W. De Vis, R. L. Jack, Hon. A. Norton, R. H. Roe, J. Shirley, J. P. Thomson, and G. Watkins.

Auditors:—Hon. A. Norton and Mr. R. A. Dallen.

On the motion of Professor RENNIE it was resolved that "The subscription for each session shall be £1"—Carried.

Professor KERNOT, in the absence of Mr. Love, moved that the Rules be altered so as to allow the sections to meet according to their own arrangements. After discussion the motion was negatived.

A motion by Professor RENNIE for the division of Section J was referred to the committee of the section.

Mr. L. E. GROOM gave notice of motion that Section G be divided into two sections—"Social Science" and "Agriculture."

MEETING OF THE GENERAL COUNCIL.

Friday, 18th January, 1895.

EXTRACTS FROM THE MINUTES.

The President, Hon. A. C. GREGORY, C.M.G., occupied the chair, and was supported on the platform by His Excellency Sir Henry W. Norman, Vice-President; Professor Liversidge, Permanent Secretary; and Mr. John Shirley, General Secretary.

Mr. SHIRLEY read the report of the Recommendation Committee, as follows:—

1. That the Committee for the investigation of the thermo-dynamics of the voltaic cell be reappointed without a grant.

2. That the report of the Seismological Committee be printed, and that the Committee be reappointed, and allowed a grant of £10 towards the cost of the erection at Timaru of the instruments presented by Dr. von Rebeur-Paschwitz.

3. On the report of Section B, Chemistry, it is recommended that one of the Vice-Presidents of that section be a pharmaceutical chemist.

4. This Committee does not recommend the proposed application to the (Queensland) Government for the extension of the Bellenden-Ker Reserve.

5. This Committee recommends, on the report of Section D, that the following be a committee:—Messrs. F. M. Bailey, F.L.S.; R. L. Jack, F.G.S.; A. Gibb Maitland, A. Meston, C. W. De Vis, and H. Tryon—to investigate the geology, land flora, land fauna, and natural resources generally of the islands and islets of the Great Barrier Reef.

6. On the report of Section D, that the New Zealand Government be asked to set apart Stephens Island, Cook Strait, as a reserve for the Tuatara lizard.

7. On the report of Section C, that the Committee for the investigation of glacial deposits in Australasia be Messrs. Hutton, R. L. Jack, R. Tate, R. M. Johnstone, T. W. E. David (secretary), G. Sweet, J. Stirling, W. Howchin, E. G. Hogg, E. J. Dunn, A. Montgomery, and E. F. Pittman.

8. This Committee does not recommend for action the joint reports of Sections G and J, or the separate report of Section G, for the division of the last named section into (*a*) Economic and Political Science, and (*b*) Agriculture.

9. On the report of Section H, that a committee, consisting of Messrs. H. C. Stanley, A. B. Brady, Thomas Parker, Henry Moncrieff, James Fincham, and Professors Warren and Kernot, be appointed to inquire into the habits of the teredo, and the best means of preserving timber or structures subject to the action of tidal waters.

10. This Committee recommends that the resolutions from Section I, *re* Infectious Diseases (Notification) Act, Federal Quarantine, and Tuberculosis, be deferred for consideration at the next session of the Association.

11. On the report of Section J, that the committee on psycho-physical research be reappointed without a grant.

12. This Committee does not recommend that the report from Section C, Geology, *re* the use of the photographic camera in topographical and other surveys be forwarded to the Governments of the other Australasian colonies.

13. This Committee recommends, on the report of Section G, Economic Science Division, that the following committee be appointed to consider the suggestions contained in Sir Samuel Griffith's paper, entitled "A Plea for the Study of the Unconscious Vital Processes in the Life of a Community," and to report how far it is practicable, by the compilation of statistics, to give effect to any of those suggestions; such committee to consist of Professors Scott and Anderson, Sir S. W. Griffith, Dr. Belcher, and the Government Statisticians of the Australian colonies, and that Mr. L. E. Groom be Secretary to the Committee.

Dr. Springthorpe asked why the recommendations of the Committee of Section I, Sanitary Science and Hygiene, were not adopted.

The President then put the question—"That the report of the Recommendation Committee be received, save the contentious issues raised by the committee of Section I"—Carried.

The Permanent Secretary explained that the reason for not endorsing the recommendations of the Committee of Section I was that they raised such momentous issues that it was deemed advisable to postpone consideration of them to the next meeting.

Dr. Springthorpe said he regretted to appear to oppose the report of the Recommendation Committee in any way, but he had no alternative. The question was whether these issues should be dealt with now or deferred. He considered the Committee of the Section, consisting largely of medical experts, was the best judge. To put the matter in definite form, he would move, "That the recommendations of the Committee of Section I be adopted."

Dr. Hardie seconded the motion.

Mr. Shirley hoped that no antagonism whatever existed between any sections of the Association. They should remember that the resolutions they were asked to pass dealt with much contentious matter.

Dr. Springthorpe spoke in reply.

The resolutions were amended to the effect—(1) That a system of compulsory notification of infectious diseases be introduced; (2) That a system of federal quarantine is desirable, and that the various Governments be approached to that effect; (3) That stock, the milk or flesh of which was intended for consumption, should be examined by duly qualified men, and slaughtered if found tuberculous or cancerous.

As amended, the resolutions were put to the meeting, and carried.

On the motion of Mr. H. C. Russell, it was resolved that the next meeting of the Association be held in Sydney, two years hence.

On the motion of Professor KERNOT, it was resolved that the meeting next after the Sydney meeting be held at Melbourne.

The following votes of thanks were put separately to the meeting, and carried unanimously :—That the best thanks of the Association be tendered to :—

1. His Excellency the Governor, for his invaluable assistance in the work of the Association, for his generous hospitality, and kindness in entertaining the visitors.

2. The Parliament of Queensland, for the grant of £500, for postage and telegrams, for free printing of the volume of the Association's proceedings, and for the use of the Government steamers.

3. The Governments of the other colonies, for similar concessions *re* postage and telegrams.

4. The Grammar School trustees, for the use of the boys' and girls' school buildings, and to Mr. and Mrs. Roe for their great help and marked hospitality.

5. The local Reception Committees at Bundaberg, Gympie, and Toowoomba. The Committees of the Queensland and Johnsonian Clubs, for hospitality to members.

6. The Bishop of Brisbane, Professor Shelton, Messrs. R. Edwards, R. Gailey, P. McLean, G. Watkins, and J. L. Woolcock, for hospitality to members.

7. The members of the medical profession, and the Councils of the Royal and Royal Geographical Societies.

8. The Brisbane Newspaper Company and the Telegraph Newspaper Company.

9. The Mayor of Brisbane, the officers of the Agricultural Department, and the Council of the Acclimatisation Society, for decorations and plants.

10. The Australian United Steam Navigation Company, Howard Smith and Company, the Adelaide Steamship Company, and the Railway authorities of New South Wales, Victoria, South Australia, Tasmania, and Queensland, for concessions in fares.

11. Mr. H. C. Russell and Dr. Cobb, for lectures.

12. Mr. John Shirley, the Queensland Council, and the Reception Committee.

13. Mr. J. S. Kerr, as editor of the Official Journal.

In acknowledging the vote of thanks accorded him by the Association, His Excellency said that as representative of the Queen, and head of the Government, he considered he had only performed his duty in endeavouring to do what lay in his power to forward the great aims the Association had in view.

In moving a vote of thanks to the Press, Professor SCOTT drew the attention of the Association to the fact that the Press had been a most able coadjutor throughout. The papers of all sections had been summarised with intelligence and accuracy, and had been made available for the general public. The labour must have been immense, and the Press deserved the hearty thanks of the Association.

TABLE SHOWING THE NUMBER OF MEMBERS PRESENT, RECEIPTS, AND GRANTS MADE, AT THE ANNUAL MEETINGS OF THE ASSOCIATION.

Date of Meeting.	Place of Meeting.	President.	Secretaries.	Attended by.		Total.	Amount Received up to and during Meeting.	Sums Granted for Scientific Purposes.
				Members.	Ladies.		£ s. d.	£ s. d.
1888 {Aug. Sept.	Sydney, New South Wales	H. C. Russell, C.M.G., B.A., F.R.S.	A. Liversidge, M.A., F.R.S. George Bennett, M.D., F.L.S., F.Z.S.	805	45	850	858 8 0	...
1890—Jan.	Melbourne, Victoria	Baron von Mueller, K.C.M.G., Ph.D., F.R.S.	W. Baldwin Spencer, M.A.	1,081	81	1,162	2,081 0 0	...
1891—Jan.	Christchurch, New Zealand	Sir James Hector, K.C.M.G., F.R.S.	F. W. Hutton, F.R.S., F.G.S., C.M.Z.S.	...	...	550	785 13 7	25 0 0
1892—Jan.	Hobart, Tasmania	His Excellency Sir Robert G. C. Hamilton, K.C.B., LL.D.	A. Morton, F.L.S. ...	...	...	600	933 16 3	...
1893—Sept.	Adelaide, South Australia	Ralph Tate, F.G.S., F.L.S.	E. H. Rennie, M.A., D.Sc. W. H. Bragg, M.A.	367	121	488	*426 2 0	30 0 0
1895—Jan.	Brisbane, Queensland	Hon. A. C. Gregory, C.M.G., F.R.G.S., M.L.C.	John Shirley, B.Sc. C. W. De Vis, M.A. ...	392	{122 †10}	524	‡858 7 2	10 0 0

* This sum represents the amount collected within the colony in which the meeting took place. † Students, youths under 21.
‡ From all sources in Queensland only.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Hon. Local Treasurer's Account of Receipts and Expenditure for the Brisbane Meeting, 1895.

30th June, 1895.		£ s. d.	£ s. d.
To Subscriptions—			
292 Full-paying members	gross	292 16 0	
122 Ladies	at 5s.	30 10 0	
10 Students	at 5s.	2 10 0	
			325 16 0
,, Receipts on excursion account			25 16 0
,, Discount on cheques		4 6 8	
,, Repayments		0 18 0	
,, Articles sold at cost price		1 10 6	
			6 15 2
,, Government subsidy			500 0 0
			£858 7 2

30th June, 1895.	£ s. d.	£ s. d.
By General expenses		284 8 0
,, Excursions and catering		79 7 9
,, Printing, stationery, and advertising ...		189 13 9
,, Balance of endowment repayable to Government	115 5 8	
,, Available credit balance	189 12 0	
		304 17 8
		£858 7 2

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Brisbane, 18th July, 1895.

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DONATIONS FROM 15TH NOVEMBER, 1893, TO 30TH JUNE, 1895.

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ALBANY, U.S.A.	New York State Museum of Natural History : Bulletin, Vol. III., No. XI., 1893.	*The Regents.*
BALTIMORE, U.S.A.	John Hopkins University : Circulars, Vol. XIII., No. 108. ,, ,, XIII., Nos. 110-114. ,, ,, XIV., Nos. 115-118. Studies from the Biological Laboratory, Vol. V., Nos. 2-4.	*The University.*
BIRMINGHAM ...	Birmingham and Midland Institute : Report of the Council for 1892, 1893, and 1894. Results of Examination and Award of Prizes, 1894.	*The Institute.*
BONN	Naturhistorischer Verein der Preussischen Rheinlande, Westfalens und des Reg.—Bezirks Osnabrück : Verhandlungen, Jahrgang L., Folge 5, Band 10, Hälfte 2, 1893 ; Jahrgang LI., Folge 6, Band 11, Hälfte 1, 1894.	*The Society.*
BREMEN ...	Naturwissenschaftlicher Verein zu Bremen : Abhandlungen, Band XII., Heft. 1, 2, 1894-5.	*The Society.*
	Ueber Einheitlichkeit der botanischenkunstausdrücke und Abkürzungen : (Extra-Beilage), Band XIII., Heft 1. Beiträge zur Nordwestdeutschen Volks und Landeskunde, Heft 1, Band XV., 1895.	*The Society.*
BRISBANE, Q. ...	Royal Geographical Society of Australasia (Queensland Branch) : Proceedings and Transactions, Vol. IX., 1893-4	*The Society*
	Royal Society of Queensland : Proceedings, Vols. I. to XI., Part I., 1884 to 1895 inclusive, and Index to Vols. VII., VIII., IX.	*The Society.*
CAPE TOWN ...	South African Philosophical Society : Transactions, Vol. V., Part II., 1886-89. ,, ,, VII. ,, I., 1893. ,, ,, VIII. ,, I., 1890-92.	*The Society.*
CHRISTIANIA ...	L'Université Royale de Norvège : Beskrivelse af En Raekke Norske Bergarter af Dr. Th. Kjerulf.	*The University.*
DUMFRIES ...	Dumfriesshire and Galloway Natural History and Antiquarian Society : Transactions and Journal of Proceedings, Nos. IX., X., 1892-4.	*The Society.*

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FREIBURG (Baden)	Naturforschende Gesellschaft : Berichte, Band VII., Heft. 1, 2. ,, ,, VIII.	*The Society.*
GENEVA ...	Société Helvétique des Sciences Naturelles : Compte Rendu des Travaux, 75me, 76me, Sessions, 1892, 1893 ; Actes, 75me, 76me, Sessions 1892, 1893.	*The Society.*
GÖTTINGEN ...	Königliche Gesellschaft der Wissenschafter zu Göttingen : Nachrichten, 1892, Nos. 1-16. ,, 1893, Nos. 12, 15-21. ,, 1894, Nos. 1-4. Mathematisch-physikalische Klasse : Nachrichten, 1894, No. 1, Geschäftliche Mittheilungen : Nachrichten, 1895, Heft. 1, Mathematisch-physikalische Klasse.	*The Society.*
HALIFAX (Nova Scotia)	Nova Scotian Institute of Science : Proceedings and Transactions, Vol. I., 2nd Series, Part II., 1891-2.	*The Institute.*
HAMBURG ...	Verein für Naturwissenschaftliche Unterhaltung zur Hamburg : Verhandlungen, Band VIII., 1891-3.	*The Society.*
KÖNIGSBERG ...	Königliche Physikalisch-ökonomische, Gesellschaft zu Königsberg : Schriften, Jahrgang, XXXIII., 1892. ,, ,, XXXIV., 1893.	*The Society.*
LEEDS	Yorkshire College : Annual Report, XX., 1893-4.	*The College.*
LONDON ...	Royal Colonial Institute : Journal, Vol. XXVI., Parts 1, 2, 3, 4, 6, 1895. Report of the Council, XXVII., 1895.	*The Institute.*
MELBOURNE ...	Department of Mines : Report on the Victorian Coal Fields, No. 3. ,, ,, loss of Gold in the Reduction of Auriferous Veinstone in Victoria.	*The Honourable the Minister for Mines.*
	Royal Geographical Society of Australasia (Victorian Branch) : Transactions, Vol. VII., Part 1, 1889. ,, ,, VIII., ,, 2, 1891. ,, ,, IX., ,, 1, 1891. ,, ,, XI., 1894.	*The Society.*
MEXICO ...	Sociedad Cientifica "Antonia Alzate" : Memorias y Revista, Vol. VI., Nos. 11-12, 1892-3. Memorias y Revista, Vol. VII., Nos. 1-12, 1893-4. Curso de Raices por el Dr. Jesus Diaz De Leon, 4th Edition, 1893.	*The Society.*
NEWCASTLE-UPON-TYNE	North of England Institute of Mining and Mechanical Engineers : Transactions, Vol. XLII., 1892-3. ,, ,, XLIII., 1893-4. Report of the Proceedings of the Flameless Explosives Committee, Part 1, Air and Combustible Gases, by A. C. Kayll.	*The Institute.*

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	Muséum D'Histoire Naturelle: Bulletin Nos. 1, 2, 1895.	*The Museum.*
	Société D'Encouragement pour L'Industrie Nationale: Bulletin, Tome VIII., Series 4, Nos. 92-96, 1893. Bulletin, Tome IX., Series 4, Nos. 97-108, 1894. Bulletin, Tome X., Series 4, Nos. 109-112, 1895. Annuaire pour Les Anneés, 1894-5. Unification des Filetages et des Janges de Tréfilerie, 1894.	*The Society.*
Penzance ...	Royal Geological Society of Cornwall: Annual Report, Vol. XI., Part VIII., 1894. Transactions, Vol. XI., Part IX., No. LXXXI., 1894-5. Laws and Rules, 1894.	*The Society.*
Pisa	Società Toscana di Scienze Naturali: Atti, Vol. VIII., May, July, 1893. ,, ,, IX., March, 1894 to March, 1895.	*The Society.*
Quebec (Canada)	Literary and Historical Society of Quebec: Transactions, New Series, Nos. 1-3, 1863-65. ,, ,, ,, 6-21, 1867-92.	*The Society.*
St. John, N.B. (Canada)	Natural History Society of New Brunswick: Bulletin, Nos. VI. to XII., 1887-94.	*The Society.*
Stockholm ...	Konigliga Svenska Vetenskaps-Akademien: Bilang, Vol. XVII., 1892. ,, ,, XVIII., 1893. ,, ,, XIX., 1894. Ofversigt, Vol. XLIX., 1892. ,, ,, L., 1893. Carl von Linnés Brefvexling af Ewald Ährling	*The Academy.*
Sydney ...	Engineering Association of New South Wales: Proceedings, Vol. VIII., 1892-93.	*The Association.*
	New South Wales Government Statistics; Census of 1891—Statistician's Report; Results of a Census of the Colony of New South Wales, taken for the night of 5th April, 1891, Parts I. to VII.; Results of the Census of the seven Colonies of Australasia, showing the occupations of the People; New South Wales Statistical Register, 1892, 1893, and previous years; The Seven Colonies of Australasia, 1893, 1894; Wealth and Progress of New South Wales, 1893; Statistical Survey of New South Wales, 1893-94.	*The Government Statistician.*
Tōkiō	Asiatic Society of Japan: Transactions, Vol. XXI., 1893. ,, ,, XXII., Parts 1, 2, 1894. General Index, Vols. I. to XXIII.	*The Society.*
	Imperial University: Calendar, 1892-93, 1893-94.	*The University.*

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Trieste ...	Società Adriatica di Scienze Naturali : Bollettino, Vol. XV., 1893.	*The Society.*
Upsala ...	Université Royale d'Upsala : Bulletin of the Geological Institution of the University of Upsala, Vol. I., Nos. 1, 2, 1892-3.	*The University.*
Washington, U.S.A.	Smithsonian Institution : Report of the U. S. National Museum, 1891, 1892 ; Report of the Board of Regents, 1891.	*The Institution.*
	U. S. Geological Survey : Annual Report (11th), Parts 1, 2, 1889-90. ,, ,, (12th), ,, 1, 2, 1890-91. ,, ,, (13th), ,, 1, 2, 3, 1891-92. Mineral Resources of the United States for 1891, 1892, and 1893. Monograph, Part XVII., XVIII., 1891. ,, ,, XIX., XX., 1892. ,, ,, XXI., XXII., 1893. Bulletin, Nos. 63, 64, 66, 1890. ,, ,, 82, 86, 90, 96, 1891-2. ,, ,, 97, 117, 1893-4.	*The Director.*
Wellington, N.Z.	Statistics of the Colony of New Zealand for 1893, Parts I. to VI., the New Zealand Official Year book, 1894.	*The Registrar-General.*
Zurich ..	Naturforschende Gesellschaft : Vierteljahrschrift, Vol. XXXVIII., 1893 ; XXXIX., 1894 ; XL., Heft. I, 1895. Neujahrsblatt, No. XCVI., 1894 ; XCVII., 1895.	*The Society.*

EXCHANGES AND PRESENTATIONS

MADE BY THE

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Association's Report for 1895, vol. vi., has been forwarded to the following Societies and Institutions ; should the publication not have arrived the Institution concerned is requested to communicate with the Permanent Hon. Secretary, the University, Sydney, in order that inquiry may be made.

**Exchanges of publications have been received from the Societies and Institutions distinguished by an asterisk.*

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6 VIENNA ... ... Kaiserliche Akademie der Wissenschaften.
7 ,, ... K. K. Geographische Gesellschaft.
8 ,, ... K. K. Zoologisch-Botanische Gesellschaft.

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9 BRUSSELS ... ... Académie Royale des Sciences, des Lettres et des Beaux Arts.
10 LIEGE ... ... Sociéte Royale des Sciences de Liége.
11 LUXEMBOURG ... ... Institut Royale grand-ducal de Luxembourg.
12 MONS ... ... Société des Sciences, des Arts et des Lettres du Hainaut, 27 Boulevard de l'Industrie.

CHILI.

13 SANTIAGO ... ... Sociedad Cientifica Alemana.

DENMARK.

14 COPENHAGEN ... ... Société Royale des Antiquaires du Nord.

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16 CAEN ... ... Académie Nationale des Sciences, Arts et Belles-Lettres.
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19 LYONS ... ... Académie des Sciences, Belles-Lettres et Arts.
20 MARSEILLES ... ...*Faculté des Sciences de Marseille.
21 MONTPELLIER... ... Académie des Sciences et Lettres.
22 NANTES ... ... Société des Sciences Naturelles de l'Ouest de la France.
23 PARIS ... ... Académie des Sciences de l'Institut de France.
24 ,, ... *Annuaire Géologique Universel.*
A.—Address to Monsier G. Ramond, Assistant de Géologie au Muséum d' Historie Naturelle, 61 Rue de Buffon (for A. G. U.).
25 PARIS ... ... Association Francaise pour l'Avancement des Sciences, Rue Antoine Dubois, 4.
26 ,, ... Bibliothéque de l'Université a la Sorbonne.
27 ,, ... Faculté des Sciences de la Sorbonne.

28 PARIS ... ... Jardin des Plantes.
29 ,, ...*Musée d'Histoire Naturelle, 8 Rue de Buffon.
30 ,, ... Ministère de l'Instruction Publique, des Beaux Arts, et des Cultes.
31 ,, ...*Société d' Encouragement pour l' Industrie Nationale, 44 Rue de Rennes.
32 ,, ...*Société Francaise de Minéralogie, au Laboratoire de Mineralogie, Sorbonne.
33 ,, ... Société Philotechnique.
34 TOULOUSE ... Académie des Sciences, Inscriptions et Belles-Lettres, Place Dupuy, 26.

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35 BERLIN ... ... Deutsche Chemische Gesellschaft.
36 ,, ... Königlich Preussische Akademie der Wissenschaften.
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39 BRUNSWICK ... ... Vereins für Naturwissenschaft zu Braunschweig.
40 CARLSRUHE ... .. Naturwissenschaftlicher Verein zu Carlsruhe.
41 CHEMNITZ ... ... Naturwissenschaftliche Gesellschaft zu Chemnitz.
42 DRESDEN ... ... Statistisches Bureau des Ministeriums des Innern zu Dresden.
43 FRANKFURT A/M ... Senckenbergische Naturforschende Gesellschaft.
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46 GORLITZ ... ...*Naturforschende Gesellschaft in Görlitz.
47 GOTTINGEN ... ..*Königliche Gesellschaft der Wissenschaften in Göttingen.
48 HALLE, A.S. ... ...*Kaiserliche Leopoldina—Carolina Akademie der Deutschen Naturforscher.
49 HAMBURG ... .*Naturhistorisches Museum.
50 ,, ...*Verein fur Naturwissenschaftliche Unterhaltung in Hamburg.
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55 MARBURG ... ...*Gesellschaft zur Beförderung der gesammten Naturwissenschaften in Marburg.
56 MUNICH ... ... Königlich Bayerische Akademie der Wissenschaften in Munchen.
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59 ,, ...*Birmingham Philosophical Society, Mason College.
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68 ,, ... Anthropological Institute of Great Britain and Ireland.
69 ,, ... British Association for the Advancement of Science, Burlington House, W.
70 ,, ... British Museum.
71 ,, ... British Museum (Natural History), Cromwell road.
72 ,, ... Chemical Society, Burlington House.
73 ,, ... Colonial Office, Downing street.
74 ,, ... Folk Lore Society, 11 Old Square, Lincolns Inn.
75 ,, ... Geological Society, Burlington House.
76 ,, ... Guildhall Library, Guildhall.
77 ,, ... Institute of Chemistry of Great Britain and Ireland, 30 Bloomsbury Square.
78 ,, ... Institution of Civil Engineers.
79 ,, ... Iron and Steel Institute, 28 Victoria street.
80 ,, ... Library, South Kensington Museum.
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83 ,, ... Museum of Practical Geology, Jermyn street.

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86 ,, ... Royal Astronomical Society.
87 ,, ...*Royal Colonial Institute.
88 ,, ... Royal Geographical Society.
89 ,, ... Royal School of Mines, South Kensington.
90 ,, ... Royal Society, Burlington House.
91 ,, ... Society of Arts, Adelphi.
92 ,, ... University of London, Burlington Gardens, W.
93 MANCHESTER .. ... Literary and Philosophical Society, 36 George street.
94 ,, ... Owens College.
95 NEWCASTLE - UPON-TYNE ... Natural History Society of Northumberland, Durham, and Newcastle upon-Tyne, Barras Buildings.
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126 ,, ... Field Naturalists' Society, 275 Pitt street.
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128 ,, ...*Government Statistician.
129 ,, ... Institute of Architects, 12 and 14 O'Connell street.
130 ,, ... Linnean Society of New South Wales, Elizabeth Bay.
131 ,, ... Observatory.
132 ,, ... Parliamentary Library, Macquarie street.
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191 Florence ... ... Reale Museo Zoologia (Vertebrati), 19, Via Romana.
192 Milan ... ... Reale Istituto Lombardo di Scienze Lettere ed Arti.
193 Modena ... ... R. Accademia di Scienze Lettere ed Arti.
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217 St. Petersburg ... Académie Impériale des Sciences.

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232 Chicago . .. Academy of Sciences.
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235 Newhaven (Conn.) American Journal of Science.
236 ,, ... Connecticut Academy of Arts and Sciences.
237 ,, ... Yale University
238 New York ... ... American Institute of Mining Engineers.
239 ,, .. .*New York Academy of Sciences.
240 ,, ...*"Science" (The Editor), 41 East Forty-ninth street.
241 ,, ...*School of Mines, Columbia College.
242 Palo Alto (Cal.) .. Geological Survey of Arkansas.
243 Philadelphia ... Academy of Natural Science.
244 ,, ... American Philosophical Society.
245 ,, ... Franklin Intitute.
246 Salem (Mass.) ..*American Association for Advancement of Science.
247 San Francisco ..*California Academy of Sciences.
248 Washington (D.C.) Microscopical Publishing Company (The Editor).
249 ,, ... National Academy of Sciences.
250 ,, ...*Philosophical Society.
251 ,, ...*Smithsonian Institution.
252 ,, ...*U.S. Geological Survey.
253 ,, ...*U.S. National Museum (Department of the Interior

ERRATA.

Page 299, line 36—For "lignified" read "liquified."
,, 340 ,, 29—For "Blythyesdale" read "Blythesdale."
,, 343 ,, 11—For "presence" read "pressure."
,, 530 ,, 15—For "Teegu" read "Teegee."
,, 531 ,, 1—For "Plate I" read "Plate VI."
,, 586 ,, 47—For "Foulah-Djalou" read "Foutah-Djalon."

Note.—Through an oversight the Report of the Seismological Committee appears out of its proper position.

INAUGURAL ADDRESS

BY THE

HON. A. C. GREGORY, C.M.G.,

PRESIDENT,

BRISBANE, SATURDAY, 12th JANUARY, 1895.

The acceptance of the honourable position of president of such an important body as the Australasian Association for the Advancement of Science involves the responsible duty of delivering a presidential address, and the difficulty of selecting a suitable subject is greatly increased by an exhaustive treatment of many branches of research by the gifted members of the association at its previous meetings, while I am satisfied that there can scarcely be a branch of science in which some of those present at this meeting are not more eminently qualified to instruct me than I am of adding to their stores of information. Under these conditions, the subject chosen is,

THE GEOGRAPHICAL HISTORY OF THE AUSTRALIAN CONTINENT DURING ITS SUCCESSIVE PHASES OF GEOLOGICAL DEVELOPMENT,

the reason being that it affords an opportunity for recording results of a personal inspection of a larger proportion of our territory than usually falls to the lot of a single individual, and there is the further advantage that the skeleton outline will afford ample scope for my more gifted colleagues, each in his own province, to correct errors and fill in details.

PRIMARY CONDITION AND FORM OF LAND.

In dealing with the geological history of Australia, it is convenient to refer to the groups of formation, as the scope of this address is insufficient for the separate consideration of the component members of each group which has taken prominent part in the geographical establishment of sea and land. Like all histories of remote events, the evidence of what was the primary condition and form of the land is necessarily of very limited character, but some evidence does remain for our guidance. The earliest indications of the existence of land within the limit of the present Australian continent consists in the fact that many of the more elevated summits are composed of granite, which is certainly the oldest rock formation with which we are acquainted.

It is here necessary to state that the term "granite" is used to indicate ancient or continental granite, and that the granitoid rocks, which are so closely allied in lithological aspect as to pass under the same designation, are really intrusive masses of more recent extrusion, even as late as the Permo-Carboniferous period, and will be termed "intrusive granite." Now the higher portions of the granite ranges show no superincumbent strata, while sedimentary beds fold round their flanks in a manner which indicates that the edges of these strata were formed near the margin of an ancient sea, above which the more elevated masses of granite rose as islands. As an instance of this early existence of land we find on the present east coast that the granite tract of New England is flanked by Devonian slates and marine beds of spirifer limestones, in positions which indicate that their deposition was in an ocean of at least 2,000 feet in depth, above which the granite mountains rose to an elevation of 2,000 feet. Adopting similar evidence as a basis for the estimation of the area of land at this earlier date, it appears that there existed a chain of islands extending from Tasmania northerly, along the line of the present great dividing range, between the eastern and western streams, nearly to Cape York, a distance of about 2,000 miles, and with a breadth seldom exceeding 100 miles. In Western Australia a much broader area of dry land existed, in the form of a granite tableland, the western limit of which, commencing at Cape Leeuwin, extended north for 600 miles, with a straight coast line rising 500 feet to 1,000 feet above the ocean. This land had a breadth east and west of about 200 miles, but its eastern shores were comparatively low and irregular, with probably detached insular portions, more especially on the northern side, as the stratified rocks in which the West Australian gold mines are worked have an exceedingly irregular outline where they overlay the granite. Between these eastern islands and the western land, there probably existed some granite peaks which rose above the ocean, but the evidence is that they were not of important area, and principally located in the northern parts. The remainder of the present continent was covered by an ocean gradually increasing in depth from the western land to the central part, and great depths continued to the shores of the eastern islands.

SEDIMENTARY DEPOSITS.

The next step in our history is that the natural decomposition of the granite, both terrestrial and marine, supplied material for sedimentary deposits; and we find a series of imperfectly stratified grit stones, together with schists and slates, the former the results of the deposition of the coarser drifts, and the latter the more gradual deposit of the finer particles. These rocks, which are classed as

Laurentian, Cambrian, and Silurian, did not extend far from the eastern islands, and are principally developed in Queensland to the north and in Victoria to the south, but, being of marine formation, they did not then materially affect the geographical configuration, though they are important features of the present time, and are the chief sources of our tin mines; and silver, lead, and copper also exist in sufficient quantity to afford prospect of future industrial success. There is also a marked characteristic in the abundant occurrence of fluor spar, which is an exceedingly rare mineral in the later formations, while gold does not occur in important quantity except in its upper or Silurian strata in Victoria. Near Zilmantown (lat. 17 deg. 20 min. S., long. 144 deg. 30 min. E.), there are interesting developments of these rocks, which now form steep ranges with flat-bottomed valleys, in which coralline limestone, of the Devonian period, rests unconformably, and in places rises abruptly several hundred feet, presenting the form of ancient coral reefs, such as now exist on the Great Barrier reefs. In fact, they indicate that at some remote time a passage existed from the east coast to the southern part of the Gulf of Carpentaria, under similar conditions to those of the present Torres Straits, and that the subsequent elevation of the land has now placed it more than 500 feet above sea level. This description of the present state of these rocks is, however, a digression in regard to geological sequences of the early period.

FIRST APPEARANCE OF ORGANIC LIFE.

The Cambrian and Silurian period was succeeded by the Devonian, during which there is little evidence of any great variation in the limits of the sea and land, but organic remains show that the conditions were becoming more favourable for the development of marine life. The rocks consist principally of fine-grained slates, which must have been deposited in a deep sea, and in some places the now visible sections indicate a thickness of 10,000 feet.

The upper strata connected with the Devonian series have been classed by geologists as belonging to the Permo-Carboniferous, on account of the marine fossils which have been found in the Gympie series of rocks. Some difficulties, however, arise in regard to the identification of Australian rocks with those of Europe on the sole basis of the occurrence of nearly the same species of mollusca, and it may be remarked that in Central North America the appearance of fossil mollusca and plants which would in Europe indicate a definite position of strata, often occurs in rocks which lithologically and stratigraphically are of an earlier date; and the same conditions of the earlier appearance of species and genera seem to obtain in Australia, and if ultimately established would clear away many of the existing difficulties in the comparison of Australian and American fossils with those of Europe. Accepting the classification of the

Gympie rocks as Permo-Carboniferous, there was no important alteration in the geographical limits during the Devonian period, or in the earlier Permo-Carboniferous Gympie beds, but shortly after this there were very decided variations in both the area and altitude of the land. The whole of the present continental area was raised sufficiently to lift large portions of the previous sea bottom above its surface. The principal elevation was on the eastern coast, where the rise must have been several thousand feet, while on the west it was less pronounced, though the area added to the land appears to have included nearly the whole of what is now Western Australia. In regard to the intervening space between it and the eastern ranges, there is only the negative evidence of no later marine deposits to indicate that it also was above the ocean. Although the general elevation of the continent appears to have been quiescent in the western and central parts, there were violent disruptions on the eastern coast, and the strata were apparently crushed by a force from the east, which lifted them into a series of waves, showing the faces of dislocation to the east and strata sloping to the west, the most easterly wave being near the present coast-line, and the succeeding waves more gradual as they recede to the west, both in angle and height, until they merge into the level of central Australia. It is also probable that the South Australian range was also the result of this compression, causing the strata to rise in abrupt masses on an axis nearly north and south. It was at this stage of disruption and elevation of strata that the more important auriferous deposits of both the eastern and western parts of the continent were formed, and these may be divided into two classes:—(1) True fissure veins, or lodes, in which the deposits of ore are found filling fissures in the slate strata, and which are generally nearly vertical; and (2) floors of ore which occur in sheets dipping at a less angle from the horizontal than the vertical, the including rock being of crystalline character, being, in fact, intrusive granites. The dip of these sheets of ore is in the direction of the huge dykes of intrusive rock in which they occur.

AURIFEROUS DEPOSITS IN LODES.

There was not only great disruption of the strata, but igneous rocks forced themselves into the fissures in the sedimentary beds, and the resulting metamorphism of the adjacent rocks increased the confusion, as beds of slate may be traced through the transformation of their sedimentary character, by the recrystallisation of their component elements into diorites, having that peculiar structure of radiating crystals which usually characterises rocks of volcanic origin. As regards the auriferous deposits in these lodes, it appears that first simple fissures were filled with water from the ocean or deep-seated sources; but in either case the powerful electric currents which continually traverse the earth's surface east and west met resistance at the lines of disruption, and electric action being developed the mineral and metallic salts in the water in the fissure and the adjacent rocks would be decomposed, and the constituents deposited as bases, such as gold and silver, or as compounds, such as quartz, calcspar, and sulphide of iron, all which were in course of deposit at the same time, as the angles of the crystals cut into each other. The theory of thermal springs is contra-indicated as the lime appears as calcspar, a form occurring in cold solutions, and not in the form of aragonite as in hot solutions. There have been many speculations as to the sources from which the gold was derived, but that which best accords with the actual conditions is that the metal exists in very minute quantities in the mass of the adjacent rocks, from which it has been transferred through the agency of electric currents and the solvent action of alkaline chlorides, which dissolve small quantities of the precious metals, and would be subject to decomposition at the places where fissures caused greater resistance to the electric current. One remarkable circumstance is that the character of the rocks forming the sides of the fissures has an evident influence on the richness of the ores in metal; where lime, magnesia, or other alkaline compounds, or graphite enter into their composition, the gold especially is more abundant than where the rocks contain silica and alumina only.

QUEENSLAND'S GOLD MINES.

In Queensland, Gympie affords some instructive examples of fissure lodes. In some, large masses of rock have fallen into the fissure before the ore was deposited, and have formed what miners term "horses," where the lode splits into two thin sheets to again unite below the fallen mass. The Mount Morgan mine may also be cited as a case where several fissure lodes rise to the surface in close proximity. The ore was originally an auriferous pyrites, but the sulphide of iron was largely decomposed, leaving the gold disseminated through the oxide of iron. In other cases the sulphur and iron have both been dissolved out, and left cellular quartz, with gold in the cavities or as fragments of gold, mixed with minute crystals of quartz, presenting the aspect of kaolin, for which it has been mistaken.

The auriferous deposits, which occur in the intrusive granites, appear under conditions differing from the true lodes in sedimentary rocks, as the intrusive granitoid rock forms dykes which fill fissures in the older true granites, and also cut through the sedimentary slates. It bears evidence of intrusion in a state of fusion, or, at least, in plastic condition, and has subsequently crystallised, after which there has been shrinkage, causing cavities, as the sides of the dyke were held in position by the enclosing rock. The vertical shrinkage being greater than the horizontal, the cavities were nearer the horizontal than the vertical, and being afterwards filled with ore formed what are called "floors," one characteristic of which is the tendency to lenticular form, or a central maximum thickness with thinner edges. The

Charters Towers Gold Field exhibits a good illustration of this class of auriferous intrusive granite. Here the intrusive granite appears as a dyke of great thickness, exceeding a mile, with a length of twenty miles; the rock is well-crystallised quartz and felspar, with very little mica or hornblende. One shaft has been sunk 2,000 feet to a floor showing gold, and similar to the floors that outcrop on the surface. The dip of these floors is north, about 30 degrees from the horizontal, and the strike across the direction of the dyke. There are, however, no good natural cross sections, as the watercourses are small, so that the length and breadth have to be estimated to some extent by the character of the soil derived from the decomposed rock, it being more fertile than that of the other rocks in the locality. The exploratory shafts which have been sunk are in positions selected for the purpose of reaching known sheets of ore at greater depth, or under the impression that the ore deposits were true fissure lodes, and would have extension in the direction of the discovered outcrops, are therefore not calculated to extend our knowledge of the auriferous deposits. The most instructive instance of the occurrence of auriferous intrusive granite exists in the valley of the Brisbane River, near Eskdale, where a granitoid dyke 50 yards wide, cuts through a slate hill for a distance of three miles, and in places shows thin sheets of quartz containing gold; the strike is at right angles to the length of the dyke, and the dip 30 degrees. Some of the quartz sheets have been traced across the dyke to within an inch of the slate which encloses it, but there is no trace of any variation in the sedimentary slate opposite the end of the quartz. A small watercourse cuts through the dyke and exposes arsenical pyrites and iron oxide, with small particles of gold. A more accessible instance of intrusive granite is exposed in the cutting for the bywash of the Brisbane Waterworks, at Enoggera, where the igneous rock has intruded between the strata of the slate.

PERMO-CARBONIFEROUS ROCKS.

From the middle to the close of the Permo-Carboniferous period the dry land teemed with vegetation, of which the *Lepidodendron* was a conspicuous type, along the eastern division, for though this plant was most abundant in Queensland it is also found in Victoria, and on the Philips River, in West Australia, where the later Permo-Carboniferous rocks are found on the south coast, extending from Albany eastward to Israelite Bay, forming the Stirling Range, with an elevation of 3,000 feet, the Mounts Barren, and the Russell Range. The age of these rocks is determined by the occurrence of large fragments of carbonised vegetation, the aspect of which closely resembles *Lepidodendron* stems. This formation is limited to the coast district, as, at a distance of fifty miles inland, the granitic plateau is reached with its partial covering of Devonian slates. On the northern coast the Permo-Carboniferous rocks are developed in the valley of the Victoria River for 100 miles from the sea. Also on the Kimberley Gold Field, to the south-west of the Victoria.

GEOGRAPHICAL FEATURES.

The geographical features of this period appear to have been a continent somewhat similar in form to that of the present Australia; there was an elevated range along the east coast which attracted moisture and a climate favourable to vegetation, and also by rapid degradation of its rocks supplied suitable soil for tropical growth. The central interior was not favoured by such a climate, and there are few traces of either deposit or denudation. The western interior enjoyed a moderate rainfall, and the detritus was carried down towards the north and south coasts, where it was deposited in regions where the carboniferous flora flourished, though not to the same degree as in east Australia, where it laid the foundation of the great goldfields of New South Wales and Queensland.

FURTHER ELEVATION OF CONTINENT.

About the end of the Palæozoic or the commencement of the Mesozoic periods, there appears to have been a further elevation of the continent, especially in the eastern part, for though in many places the deposits of the strata show little interruption, in others there has been considerable disturbance and unconformity of succession, with indications of an increase in the elevation of the land, which, with a contingent increase of rainfall, accounts for the luxuriant growth of the carbonaceous flora and its extension much further to the west. The artesian bores which have been made, show that the cretaceous beds rest on the carbonaceous at a depth of 2,000 feet below the present ocean level, and the freshwater beds of the coal series are not less than 3,000 feet in thickness, showing that the terrestrial level of the mountains has been decreased 5,000 feet, or, in other words, they were 5,000 feet higher during the Mesozoic period. On the western coast the elevation is not so well defined, but the land was at a greater height above the ocean than at present, as fragments of coal and its accompanying minerals have been washed up from the deep sea, and may be found embedded in the Tertiary limestones of the coast. There is thus proof that on the west coast the land extended further, and was covered with the freshwater flora of the coal period; but this area is now submerged, and taking into consideration the great depth of the ocean on this coast, the height of the land must have exceeded its present level by 1,000 feet. Examining the ocean depths around the present Australian coast, even 5,000 feet would make little difference in the limits of the west, south, and south-west shores; but on the north and east the land would extend to the Great Barrier Reef, Papua would be annexed, and even the Arafura Sea and Island of Timor might have been brought within the limits of Terra Australis.

VEGETATION OF AUSTRALASIA.

The mountain ranges of the east coast would be connected with those of Papua, and form a magnificent series of summits of 10,000 feet elevation, a configuration that must have arrested the moisture from the Pacific Ocean, and resulted in a moist tropical climate, well calculated to support the luxuriant growth of the vegetation of the coal period so far as East Australia was affected, though it might also have had the effect of rendering the climate of Central and West Australia so dry as to render the land a desert during the continuance of this carbonaceous period. East Australia has thus, on its lower levels, accumulated stores of fuel for use in ages long subsequent. The luxuriant vegetation necessary to the production of coal was limited to the area east of the 140th meridian, except in a portion of South Australia, which seems to have been favoured by the overflow of some large rivers draining the western slopes of the Great Range, and had their outlet through Spencer's Gulf. The vegetation of Australia at this period, however well adapted for the formation of coal deposits, was not such as in the present would be suitable for the maintenance of mammalian life, as it consisted of ferns, cycads, palms, and pine trees, of which only the *Araucaria Bidwilli* has left a living representative, and its silicified wood from the coal formation presents exactly the same structure as the tree now growing on the ranges. Australian geography underwent little change during the Mesozoic period, but at the commencement of the Cretaceous a general subsidence of the whole continent began. The coal deposits ceased, and a freshwater deposit known as the Rolling Downs formation accumulated, the constituents being soft shales, which in the earlier periods supported a growth of ferns and pine timber. The land continued to subside until the ocean invaded a large portion of the lower lands, but only as a shallow sea, or possibly in the form of estuaries, as the freshwater vegetation appears intercalated with marine limestones containing Ammonites and other mollusca of the Cretaceous epoch.

THE CRETACEOUS PERIOD.

The depression during the Cretaceous period must have been gradual and of long continuance. The ocean apparently first covered the land near the Great Australian Bight on the south, and Arnhem's Land on the north, as in each of these localities there are extensive deposits of thick bedded limestones, which may have continuity across the continent under cover of the ferruginous sandstones of the latter part of the epoch. On the east coast the ocean rose from 100 feet to 200 feet above its present level in Queensland, as the margin of the cretaceous rocks is visible close to South Brisbane, and there is a belt along the coast from Point Danger to Gladstone. Further north there are extensive patches of Desert Sandstone belonging to this period, though the designation seems to have been applied to two distinct beds of sandstone, one belonging to the close of the Mesozoic, and the other to the last part of the Cretaceous.

GREAT DEPRESSION AND ERUPTIONS.

Ultimately the dry land was reduced to the eastern ranges, from Cape Howe northerly to latitude 15 degrees; the eastern side nearly the same as the present coast line, and extending from 100 to 300 miles westerly, while the Mount Lofty Range in South Australia existed as an island. This great depression was accompanied by dislocations of strata, and also by the eruption of porphyritic masses, the age of these eruptions being easily determined as they rest on the Ipswich coal strata. At Mount Flinders the base of the mountain consists of coal shales with abundant impressions of Pecopteris, while there is a more instructive instance near Teviot Brook, where in a deep ravine there is a dyke of porphyry cutting through a bed of carbonaceous shale, with Pecopteris and the silicified stems of pine trees embedded. The dyke itself is dark-coloured and highly crystalline, but where it spreads out into a flat sheet on the top of the hill, it assumes the same appearance as the light-coloured porphyry of Brisbane. This porphyry forms the Glasshouse Mountains, which are so conspicuous from the entrance of Moreton Bay, and also Mounts Warning, Leslie, Maroon, and Barney.

The central and western parts of the continent were almost entirely submerged in the ocean, but not to any great depth, as the higher granite peaks of the north-west do not show traces of submergence, though the sedimentary deposits approach closely to their bases. The Stirling and Mount Barren Ranges on the south coast were only partially covered, as there is an ancient sea beach on the south side of middle Mount Barren, about 300 feet above the present sea level. The interior tableland, though now of greater altitude than Mount Barren, was submerged, as evidenced by the extension over the whole of the rest of West Australia of soft sandstones and clay-stones, in which salt and gypsum are of common occurrence. On the northern coast the submergence was greater, as the sandstones and shales have a thickness of more than a thousand feet.

THE CRETACEOUS DEPOSITS.

One characteristic of the latter part of the Cretaceous deposits is that in the lower part they consist chiefly of white, blue, and pale red shales, which readily disintegrate, while the upper portion consists of variegated sandstones of a harder character, with a comparatively thin covering of ferruginous concretionary pebbles or nodules, often with a nucleus of organic origin. On the west coast (latitude 29 degrees), on Moresby's Flat-topped Range, these features are well developed, and in the upper part a bed of limestone, containing Ammonites and other mollusca of the Cretaceous series; and it was from this locality that the first proofs of the existence of the cretaceous formation in Australia were furnished to Professor McCoy. Closely associated with these limestones are ferruginous sandstones, containing casts of large accumulations of fragments of wood and vegetable *débris*, such as may be found after floods on the margins of rivers; indicating an estuary system, where fresh and salt water alternated.

AUSTRALIA AN ISLAND.

The Mesozoic period closed with Australia reduced to the area of a large island on the east coast, and some small islands on the south-west and north-west of the present continent, and thus the connection with Papua was severed before the period when mammalian life was developed.

A NEW ELEVATION.

Early in the Tertiary period a new elevation of the land commenced, but the rise was not attended by any great disturbance of the strata, as in almost every instance where the Upper Cretaceous rocks remain they are remarkable for their horizontal position. The elevation of the continent on this occasion was nearly equal in all parts. The ultimate altitude, at least 500 feet greater than at present, and the geographical effect was that Australia assumed nearly its present limits.

FEATURES OF THE CONTINENT.

The features of the continent at this time appear as high ranges on the east coast, and a nearly level tableland extending to the west coast, but the whole of the interior with a general incline towards Spencer's Gulf. Short watercourses flowed direct to the sea, but far the greater area was drained by much longer streams towards Spencer's Gulf, while a secondary series occupied the basin of the Murray and Darling Rivers. The climate evidently differed greatly from that now existent, as the denudations of the tableland removed tracts of country having an area of many hundreds of square miles, forming immense valleys bounded by flat-topped hills and ranges, representing the marginal remnants of the original surface. Enormous quantities of the finer-grained portions of the degraded shales must have been swept into the ocean by the rivers, but the coarser sands have been left in what is now the desert interior, where the wind drifts it into long steep ridges of bright red sand, having a northerly direction near the south coast, but spreading out like a fan to the east and west in the Northern interior.

VALLEYS AND RIVER SYSTEMS.

The interior rivers formed a grand feature of the country so long as the rainfall continued sufficiently copious to maintain their flow, but in the arid climate which now obtains it does not even compensate for the evaporation. The river channels have been nearly obliterated, and some parts of the wider valleys changed to salt marshes or lakes, such as Lakes Amadeus and Torrens, while the entrance to Spencer's Gulf is choked with sand. It was during this period, when the great valleys of the river systems were being excavated, that a great proportion of the outbursts of volcanic rock in the form of basalt occurred. The age of these basalts is established by their superposition on cretaceous rocks. Thus, at Roma, the Grafton Range is a mass of basalt, resting on the cretaceous sandstones and shales. Mount Bindango is a similar instance. On the Upper Warrego there is a deep ravine through cretaceous rocks partly undermining a basaltic cone. On the Victoria River a large basin has been eroded in the cretaceous rocks, and then several hundred square miles flooded by an eruption of basalt, through which watercourses have cut instructive sections, showing the subordinate sandstones baked and fused by contact, and the cracks filled by the covering basalt.

It does not appear that the eruption of basalt has materially affected the geographical outline of the coast, but there were considerable variations of level, and important tracts of fertile country were formed by the basaltic detritus, such as Peak Downs and Darling Downs in Queensland, and to the west of Melbourne in the south.

LARGE ANIMAL PERIOD.

It was not till after the convulsions which attended this outflow of basalt, and lakes, marshes, and rivers had been formed, and produced a luxuriant growth of vegetation, that the gigantic marsupials gave any decisive evidence of their advent, as their fossil remains are found in the drifts of watercourses mixed with basaltic pebbles and detritus. The physical conditions of the country during the period of the Diprotodon, Nototherium, and associated fauna, differed materially from that which now subsists, for the structure of the larger quadrupeds would render them incapable of obtaining a subsistence from the short herbage now existing in the same localities, and it is evident that their food was of a large succulent growth, such as is found only in moist climates and marshy lands or lake margins. This view is also supported by the fact that on the Darling Downs and Peak Downs the associated fossils include crocodile and turtle, so that what are now open grassy plains must have been lakes or swamps, into which the streams from the adjacent basaltic hills flowed, and gradually filling the hollows with detritus, formed level plains.

ENORMOUS RAINFALLS.

That this gradual filling up of lakes actually occurred is shown by the beds of drift which are found in sinking wells and in sections exposed by erosion of watercourses; but in all these instances there is evidence that the ancient rainfall was excessive, as even our present wettest seasons are inadequate to the removal of the quantities of drift which has been the result of a single flood in the ancient period. On the ridges around the lakes there existed a forest growth, as many species of opossum have left their bones as evidence; but the timber evidently differed from the present scanty growth of eucalypti. Whether the same abundant rainfall extended far into the western interior is uncertain, but the rivers evidently maintained a luxuriant vegetation adapted to the sustenance of these gigantic animals, as the discovery of a nearly complete skeleton of Diprotodon on the shore of Lake Mulligan, in South Australia, shows that these animals lived in this locality, as it is not probable that their bodies could have floated down the great river which drained the interior of the continent through Lake Eyre.

ANOTHER CHANGE.

It is evident that the climate gradually became drier, that the rivers nearly ceased their flow, and the lakes and marshes became dry land, while the vegetation was reduced to short grasses that no longer sufficed for the subsistence of the huge Diprotodon and gigantic kangaroo, though some of the smaller may still survive to keep company with the dingo, who, while he left the impressions of his teeth in the bones of the Diprotodon, has shown a greater facility for adapting himself to altered conditions. Is this the survival of the fittest? It was in these later days that some of the rivers flowing direct to the coast cut through the sandstones into the softer shales beneath, and by their erosion formed considerable valleys bounded by rocky cliffs, and when the land was subsequently depressed the sea flowed in and formed inlets, of which Sydney Harbour, and the entrance to the Hawkesbury River on the east coast, Port Darwin, and Cambridge Gulf on the north-west, and the Pallinup River on the south-west of the continent may be cited as examples.

CONCLUSION.

Thus Australia, after its first appearance in the form of a group of small islands on the east, and a larger island on the west, was raised at the close of the Palæozoic period into a continent of at least double its present area, including Papua, and with a mountain range of great altitude. In the Mesozoic times, after a grand growth of vegetation which formed its coal beds, it was destined to be almost entirely submerged in the cretaceous sea, but was again resuscitated in the Tertiary period with the geographical form it now presents. Thus its climate at the time of this last elevation maintained a magnificent system of rivers, which drained the interior into Spencer's Gulf, but the gradual decrease in rainfall has dried up these watercourses, and their channels have been nearly obliterated, and the country changed from one of great fertility to a comparatively desert interior, which can only be partially reclaimed by the deep boring of artesian wells.

Section A.

ASTRONOMY, MATHEMATICS, AND PHYSICS.

ADDRESS BY THE PRESIDENT,

ALEXANDER McAULAY, M.A.

ON SOME POPULAR MISCONCEPTIONS OF THE NATURE OF MATHEMATICAL THOUGHT.

It is with feelings of reluctance akin to fear that I have ventured to accept the high honour of being the President of this Section and of framing this address.

The choice of a subject has been the cause of no little hesitation. I do not feel competent to give a review of recent mathematical or physical work. The special branches of mathematics which I have most studied by no means lend themselves to treatment in a general address. At the risk, then, of being accused of throwing away energy on the killing of a very dead horse, I have decided to speak on a well-worn theme. What I have to say will probably appear to one class a string of platitudes, and to another to be tinged with hyperbole. In self-defence let me ask each class to remember that the other does exist.

I read that among other objects of the Association are "to give a stronger impulse to scientific inquiry," and "to promote the intercourse of those who cultivate science with one another." I am bold enough, therefore, to attempt to appeal first to those whose scientific bent is not so pronounced as some other bent, and secondly to those who, while pursuing science, have little or no sympathy with what they regard as the dry pursuits of such as busy themselves with the so-called exact sciences.

The pursuit of science has to-day grown to be quite a respectable, not to say a fashionable, occupation. Nobody scarcely nowadays is content without evidence. Would that the power of justly discriminating the value of evidence were as universal as the craving for it. Many of the highest minds, perhaps the majority, share this public thirst for evidence. They teach that we must not rest content with what we are told. We must not even believe our undisciplined senses. But after the listening and after the disciplining—especially the latter—we must trust to our educated instinct.

But alongside the present-day popular kindly welcome of science, naturally is to be seen a corresponding reaction. "Let us go back to first principles," say some. "How can we analyse the conflict of testimony?" say others. "We believe this we believe that," say all. There is, I believe, a growing disposition among a large mass of the unscientific to say—"What is science after all? Have you not done away with some of our older authorities to whom we were taught to bow, only to set up others in their place? Why do scientists so presumptuously consider that their methods of inquiry are so superior to all other methods? There are large differences of opinion among the very leaders of science. You are as unreliable as any other guides, and surely the subjects on which you ostentatiously proffer advice are not of such wide human interest as those on which others speak."

And this class of thinkers is liable to regard mathematics as the scientific method run mad. To them it seems that the subject matters of mathematics are worse than lacking in human interest; they are absolutely demoralising by reason of their great omissions. And the mental tasks of mathematics seem to these on no higher level than the guessing of conundrums. The scoffers think that the man who examines dead matter has a dead soul. As well might you say that because a poet reaches you through the medium of words he ought to be an expert lexicographer.

Human kind is so knitted together that it is necessary for self-preservation that we outcasts assert our brotherhood to the rest. If others will recognise nothing else in common, let us insist on our common frailties.

Perhaps the class that as a whole is most desirous and ever ready to mete out withering scorn to the mathematician is that of the metaphysicians. And it must be confessed that the debt is repaid in the same coin by many mathematicians. No doubt both classes will be able to give ample reasons for their attitudes, but I cannot believe that either is justified in the slightest degree.

The metaphysicians, perhaps to an even greater extent than the frequenters of our section, are regarded by many as cumberers of the ground that can be but just tolerated. Even in this Association they are denied a section. They have, however, very much in common with us. Even Professor P. G. Tait, who no doubt would regard it as a compliment to be called the champion of the mathematical world against metaphysics, has himself been accused of dealing in the unclean thing. It is too delicate a matter for me to say whether I think this accusation warranted by the facts. It is but an example of how some mathematicians and physicists regard the work of others. Professor Tait is acknowledged by all to be a clear-headed logical arguer from his experimental or mathematical premises. And yet both on the mathematical and on the physical side he has been accused by those who have apparently as great a contempt as he for metaphysical reasoning, of using such reasoning himself. I do not deny that on the whole the mathematician's and metaphysician's main methods are vastly different. I think that these methods are perhaps as far apart as two useful methods of arriving at what seems truth to us groping mortals can well be. Nevertheless, I think that there is something more than a wish to put things strongly at the bottom of these amenities. I believe that all kinds of human reasoning are subject to certain common classes of misdirection and true direction, and that when we are in the position of only viewing from a distance the effect of the one or the other, we see more clearly how the particular reasoning resembles that of an apparently widely different type. Wallace seems in his "Darwinism" to be utterly unconscious that the arguments he bases on the existence of a "Mathematical faculty" and a "Musical faculty" are equally applicable to all human reasoning and emotion. It is, perhaps, only the mathematician or the musician who can fully appreciate how all his specialised work merges into his everyday ideas.

But, says one haughty mathematician, our reasoning has more validity than the metaphysicians', in that it is based upon a rock. It may be, but without any doubt that rock is essentially metaphysical. Another says it is the process and not the foundation that makes all the difference. How comes it then that to those most skilled, unfamiliar mathematical processes and unfamiliar physical reasoning (like Faraday's, as viewed by his contemporaries) of the most advanced type, based on the thoughts and labours of multitudes of previous natural philosophers—how comes it that these processes above all seem to smack of metaphysics?

Let us examine a stone or two of those rocky foundations. If two and two do not always make four, a very considerable part of modern mathematical and physical ideas must vanish like a dream that is forgotten. And yet can any mathematician *prove* that two and two do without exception make four? Your mathematician will smile a contemptuous smile, and will whisper—Is he mad? Your metaphysician, on the other hand, will say—Here is a concatenation of words that apparently forms a rational question. In the first place is it rational—*i.e.*, is it other than nonsense? He examines the words on this side and on that, and he concludes that the question is not nonsensical. He does not say that he can conceive an order of things in which two and two do not make four, but he does say that an order is conceivable in which both the assertion and its negation are nonsense. He says: Conceive three bags—one containing white balls, one black balls, and the third empty. Now take out a white and black ball, and put them in the third bag; then take out another white and black ball, and put them in the third bag. Continue the operation till the white or black balls are exhausted. Suppose that both are exhausted simultaneously. Now separate the black balls from the white, and repeat the process. Have we any reasons for supposing that again the white and black balls will be exhausted simultaneously? Undoubtedly we have, but it is merely that the same sort of thing has repeatedly occurred to us, not to say to our forefathers before. We cannot prove that because the phenomenon occurred on the first trial it will occur on the second. There is no law of thought involved—merely experience. Now, says the metaphysician, I can conceive an order of things in which this experience had no place. In such an order our labels *one*, *two*, *three*, *four*, &c., would have no meaning, and the statement that two and two made four would be a sick man's fancy.

Whether you consider such questions as belonging to the mathematician's or the metaphysician's domain, you must acknowledge that the mathematician is reduced to treating his question metaphysically, or the metaphysician to treating it mathematically. The processes in such cases merge into one another.

It is more than likely that both the average mathematician and the average metaphysician would alike regard these speculations as to the last degree frivolous, both hurrying off in different directions to more congenial pastures; but that wonderful mathematician and metaphysician, Clifford, did not so regard them. How was it that the arch-enemy of

Mathematics, Sir Wm. Hamilton, had such an influence on Maxwell? Was it not that their thoughts moved in parallel though distant channels? Kant is, I believe, held by many metaphysicians to be their greatest modern master. Does anybody deny that his power was largely owing to his scientific and especially his mathematical attainments? Professor Tait has accused the great mathematician, Sir Wm. Rowan Hamilton, of having a metaphysical twist.

The mention of Kant at once suggests the consideration of another of the foundations of mathematics—our spatial conceptions. If there are forms of thought, if there are boundaries to the region in which by our mind's constitution we must think, if there are fundamental instincts whose validity we dare not presume to impugn though we cannot trace them to a foundation in experience, surely all these receive illustration in our geometrical conceptions. Kant, if I understand (second-hand) aright, held that our mind is so constituted that a conception not bounded by the rules of Euclidean space is an impossibility. But it is notorious among mathematicians to-day that, so far from this being the case, it is now a definite physical problem to determine experimentally whether or not Euclid's ideas of space are the correct ones. If the very basis of all mathematics is thus subject to revision at any moment, surely we cannot hold that the science is differentiated in kind from other sciences by reason of the absolute certainty of premises.

The same aspect of the subject could be illustrated from the history of the acceptance by mathematicians of the ideas of positive and negative quantities, of continuous and discontinuous quantities, and of the imaginary. By some it is thought that the imaginary is now miscalled. Have we not found a real operator that possesses all the properties of the imaginary? Undoubtedly we have, so far as the imaginary appears in ordinary algebra. But no sooner do we examine this operator than we find the old imaginary appearing in the processes of the new real operator. And the worst of it is that it is as imaginary as ever.

Many volumes might be—perhaps have been, were they all collected—profitably written on the metaphysics involved in the three laws of motion. Perhaps, if physicists were better trained metaphysicians, we should cease to see a curious circularity of definition in the subject of heat. Absolute temperature is defined in terms of quantity of heat. But the meaning of absolute temperature is tacitly assumed in defining what is meant by quantity of heat.

Surely it is not the mathematician who should cast the first stone at the metaphysician, nor the latter who should perform a similar office for the former. Let each perform his allotted task for the common weal, and not waste precious energy in mutual vituperation.

But metaphysical thought is not the only activity of the mind whose relations to mathematical thought are by most totally misapprehended. Is it a daring thing to mention mathematics and emotion in the same breath? I am afraid that most people believe them to be as far asunder as the poles. But why? Joy, despair, a trembling excitement in the presence of some new vast truth, a sense of exquisite beauty, all these sometimes to an intense degree are the lot of the mathematician. You think the mathematician has no sense of beauty in his work. The veriest tyro will be able to set you right.

From the beauty of mere statuesque form to that of the most complex masterpiece performed by a grand orchestra, all forms of beauty have their analogues in the field of mathematics.

Do you laugh when it is said that a mathematician in any but a ludicrous sense experiences the feeling of despair? Have you never felt a sickening sense of incapacity to grasp some fleeting image which it is your unhappy power to know the existence of? You are certain that it contains some special truth for you, but your powers just fall short of making it reveal itself. Can you not therefore understand that the mathematician, with his specialised opportunities of instinctively realising the near presence of some idea which, if caught, would be fruitful beyond conception, should sometimes despair of the puny power of the human mind?

Ask a pure mathematician to analyse his feelings of delight mixed with painful struggle, his feelings of wonder at the harmony that reigns among his symbols, his awe of the vast regions of truth touched by his simplest formula—regions of which he knows that he himself only perceives a minute fraction—the analysis is quite beyond him. Why by many is the poet regarded as the fortunate possessor of a greater share of truth than any other? Is it not because he has the faculty of so choosing his words that they shall cover a greater portion of truth than ordinary words, indeed cover a greater portion than he is himself aware of? Is it not that he refuses to believe that formal logic is our only guide, and so throws himself for much of his guidance on his instincts? It is hard for those not behind the scenes to understand how exactly these words describe some of the moods of the pure mathematician. Glaisher I think it was who said that it would no doubt be a brilliant exaggeration to say that no mathematician understood any other mathematician. It would scarcely be a greater exaggeration to say that no mathematician understood himself. And by this I do not mean that he fails like everybody else to gauge himself as a social unit, but that he sees only a small part of the meaning of his own mathematics, that he struggles ever to bring the mathematics into harmony with nature, but he never properly realises how much is left inharmonious. He only has dim feelings that in such a direction he is almost certainly right, and in this other direction there is still something wanting. Sometimes he has a nearly definite, sometimes a faint notion, and sometimes none at all of what is wanting, but there is always something wanting.

And yet the popular fancy, fostered perhaps by misapprehension of the meaning of "exact science," is that the mathematician, by putting pen to paper, is enabled to turn a mental handle, whereupon, with unerring precision. some particular execrable barrel-organ tune bursts forth.

There is another oft-mentioned but rarely understood aspect of the mathematician's work. A smile of derision is usually all that is bestowed upon the propounder of the statement that the imagination of the mathematician is closely akin to that of the poet. The mathematician is frequently compelled to travel leagues ahead of his symbols, and centuries ahead of his facts. He makes a plausible guess, but he is convinced that it is something more. His quick thought pursues the suggestion into a thousand ramifications. He distinguishes with the eye of an experienced traveller which of these will probably best repay exploration. He follows each in turn, and judges by the general look of the country how much time and labour to expend on it. He stores in his mind the infinitely varied impressions gathered from all his excursions, and he uses these to enable him to gauge the plausibility of his guess. According to his general impression he acquits or condemns the idea. He lets it live and go forth to fructify, or he strangles it in its birth. Sometimes these investigations occupy but a second, sometimes months, sometimes years. But, however long they occupy him, they are built into him, and become a part of his future existence. Whether or not he shall prove a useful member of humanity depends largely on the rapidity with which he disentangles the maze and resolves on a course of action. It depends, perhaps, still more largely on the one hand on his fundamental love of truth; on the other hand, on his repugnance to accept unchallenged what does not tally with his laboriously formed, perhaps indistinct, beliefs, and on his recognition that, while all of us are far from the absolute truth, each possesses some specially useful instinct for the discovery of that truth which lies in a particular direction. Is the poet's method wholly different?

But the poet's heart, you say, beats in unison with all mankind, and his deeds are the heritage of the race. Granted, but let it not be supposed that this is untrue of the mathematician. Certainly his specialised work is generally not best accomplished in a convivial meeting. But his work is not for himself. Cavendish, who made scientific discoveries of the first rank and buried them, is a standing wonder to all of us. His mental constitution seems so incongruous that we have the feeling that it would be vastly more comfortable to believe that we are all under a huge mistake, and that no such man ever existed. But if this is the feeling that is universally held with regard to Cavendish by those who have heard of him, how is it that the popular notion seems to be that every mathematician is naturally of his type? Not one in a thousand of the workers in our field would continue his work for a day if he thought that no other human being would ever be influenced by it. No, his belief is that his work, however humble, is at least a small improvement in the road that leads humanity ever higher. What inspires his labours is the belief that if not to-day then to-morrow, or a hundred years hence, perhaps, one fellow-workman hidden from him in the darkness will be led to view things somewhat in his own light. And he believes that this one's thoughts and, indeed, actions will be thereby coloured in somewhat the same way as his own. He thinks that he is scattering the seed of a plant that is useful to man, and he trusts that it will spring up in places unknown to him perchance, but will benefit somebody. He thinks that others will find where his work is imperfect, and will render it useful by lopping off harmful excrescences. Sometimes, of course, he is so far mistaken as to suppose some worthless work useful, but he strives ever to train himself to be more clear-sighted.

And in a wider sense than just mentioned the mathematician's work is not for himself. It is not merely for other mathematicians. He provides means for all to have wider conceptions of the universe than would be possible without his aid. Who can deny that the world in which we live and think is a thousand times more spacious than it would have been but for the labours of mathematicians in the last three thousand years? Probably no one has sufficient imagination and culture even approximately to realise of how much we should be stripped were we back in the days before Copernicus, or those before Newton, or even those before Young, Fresnel, and Faraday.

My aim so far has been to emphasise the points of contact between mathematical and other thought. At first sight it would not seem desirable to review the peculiar characteristics of the former, as they are so much better understood than those which are not peculiar. But it is dangerous to state only the unfamiliar aspect of a question. My own experience is that if you do so your hearers will go away with the impression, and not hesitate to tell it to their friends, that you are a dangerous crank, because you do not put before them what they do believe with the same emphasis as what they have not previously believed.

I shall therefore shortly address myself to showing that I by no means believe that the unhappy mortals who do not belong to our section should congratulate themselves thereon, but rather that they should dress themselves in sackcloth and ashes till such time as they are qualified to enter. And if in some things that have been said offence has been given to the wielder of symbols, it is more than likely that all others will, for what has still to come, cry—Did ever man so presumptuously exalt his own order?

In the olden days it was the wizard who was looked upon with much fear and more contempt. And were it not that in all ages fear has proved a far greater human stimulant than contempt, the wizard would still more frequently than he did have made acquaintance with the stake. In the dim records of those times that have come down to us, we now and then get glimpses of men who were certainly not wholly quacks, but who interested themselves in groping in what seems to us a somewhat purblind fashion among Nature's secrets. At any rate, when the real scientific investigator did at length emerge, he was looked upon by his scholastically educated contemporaries only as a more than usually potent and therefore obnoxious wizard.

The story of Galileo illustrates how, at any rate for some time, the scientist seemed likely to inherit both the spell over the popular mind and the odium of the wizard. The world, it is true, has almost outgrown its childish wonder and aversion of the mysterious being who presided over crucibles and cabalistic signs. And yet I venture to think that even educated people have not altogether ceased in their hearts to regard mathematics with some such mediæval ignorance.

There must be some peculiarity of our science which causes this. If I venture to say that it is that mathematics is so distinctly the king of the sciences that even in these days of popularising of science it still remains shrouded in a distant haze from the many, I trust that I shall not be supposed to disparage the other sciences.

In the strictest sense, no science is exact. In another sense all sciences are exact. And in this latter sense one science can properly be said to be more exact than another. In this sense I think everybody who is competent to form an opinion will agree that the sciences of logic and mathematics are incomparably more exact than any other. Physics comes next, but in this respect, a great distance behind.

Let us be more precise about these two meanings of exactness.

Of those things we know, our knowledge can only strictly be called exact if it is absolutely certain. But on reflection you will perceive that certainty is our possession in but a very small and apparently rather barren field. My certainty is limited absolutely to my own consciousness. I am certain that I *feel* warm or cold; I am certain that I *see—i.e.*, have certain impressions called visual; I am certain that I *believe* there are conscious beings like but other than myself. But I am not certain that I feel warm, *because* I am in an execrable climate, though I may think it highly probable. I am not certain that what I see before me are really people's faces, whatever people and face may mean. And although I am certain of the belief in the existence of other conscious beings, the belief itself is not a certainty.

Enough of this, however. I merely wish to point out that no science is exact in the sense of dealing with certainties. But it is no violation of the English language to say that the distance between two milestones is exactly one mile. This may mean that the excess above or defect below one mile is so small as to be of no consequence in all the uses to which milestones are put, or it may mean that from a definite point on the one stone to some point unspecified on the other the distance is neither more nor less than a mile.

I have said that in this second sense all sciences are exact. And the reason is not far to seek. The whole object of science viewed from one point of view is to reduce knowledge to exactness. Just in so far as a branch of knowledge separates itself off from ordinary knowledge by reason of its becoming more and more exact does that branch justify its possession of the proud title—Science. Let me, in passing, however, protest against these words being caricatured. When I say that from one point of view the object of science is exactness, I only mean that this is the note of its method as distinguished from other methods of learning from our surroundings. The ultimate object of all science, as of all poetry, arts, and philosophies, is to bring us into closer harmony with the external universe. The scientist elects to adopt the humble and laborious task of going to Nature herself, asking questions, cross-questioning her, but, above all, cross-questioning himself in his deductions from her answers.

It would take us too far afield to try to answer in general terms the question how the various sciences have been made more and more exact till one by one they have arrived at such a growth as to fill us with never-ceasing wonder at what men and generations in concert can intellectually accomplish. Suffice it that by one such process the science of mathematics has succeeded in an astonishingly great degree to distance all others in this pre-eminently scientific aim.

Perhaps it is this feature more than any other which has caused that curious phenomenon—that quite a multitude of semi-educated scientific men find a real difficulty in understanding that mathematics is a science.

This prevalent notion seems to be connected with another one already hinted at—viz., that to become an expert mathematician the penalty must be paid of parting with half one's humanity in order to become a calculating machine. This popular delusion constantly requires to be protested against. The mathematician is very rarely a calculator. Mathematical and calculating ability indeed seem to a large extent antagonistic. It is a well-known fact that when a mathematician is brought face to face with any necessary elaborate calculation, in nine cases out of ten, his only safe course is to hand over the work to a professional calculator. The mathematician in such a case may be likened to an architect who plans some noble building, and the calculator to the stonemason and bricklayer who know all that is necessary about the art of hewing individual stones and putting joint to joint, but who have absolutely no conception of and generally no desire to conceive the design as a whole.

When your uninitiated friends look round your shelves, and furtively pick out an odd tome and glance inside, they see their native language mixed up with what seems a barbarous tongue. Those symbols are so mysterious, not to say ungainly, like many another fetish. They may for a moment exercise some fascination, but they more probably cause a slight shudder, and the volume is replaced, with the remark "how dry." The reason, of course, is sufficiently obvious. The books appear to be dry for exactly the same reason as a volume of Shakspeare would appear dry to a child of seven. But the unbelief now under consideration is unfortunately not confined merely to those who are absolutely without the pale. It ranges through a large proportion of the unscientific engineers up to some few really scientific though rather narrow-cultured physical investigators. These men have learnt to know the value of some few elementary branches of mathematics as efficient tools for certain special operations. But they are so impressed with the undoubted truth that of all the many particular problems presented to them mathematics can only provide a complete solution of a small number, and give useful hints in a few more, that they think the science certainly of a little use, but one that they would not sacrifice their best powers to. It is useless, in most cases, to tell such as these that they really know next to nothing about mathematics, seeing as they do but an accidentally straying twig of the main tree. What! a man who can boast that he knows something about the differential calculus, yet knows nothing worthy of remark about mathematics? Undoubtedly, just as the man who can make rhymes may know nothing about poetry, or the man who can put marks on a paper, which, without being told, you perceive to represent a dog and not a horse, may know nothing of art.

It is probably almost in vain that I have tried already in some slight degree to carry home to those who have not experienced it the exquisiteness of the pleasure sometimes granted to the pure mathematician in the exercise of his powers. Perhaps it would be an equally easy task to convey to the man born deaf the emotional pleasures of music. It is, perhaps, more hopeful to try to hint to such as we are now considering some of the fascinations of our science that may reasonably be expected to appeal to them.

First, consider the precision of mathematics. Probably no engineer, certainly no physicist worthy of the name, but must sometimes, probably often, have felt the intellectual freedom which appears to be gained when all at once some hazily grasped truth reveals itself in the new garb of precision. It may be that it is suddenly realised, or by some crucial experiment proved, that the data on which the truth depends are long familiar fundamental precise ones. It may be again that by the like means it is discovered that there is a precise relation not before thought of between highly general and by no means fundamental phenomena. In either case at such a moment all men feel that a real conquest has been made.

Now, one of the most characteristic features, though perhaps not universal, of mathematical processes is their precision. Mathematics is precise in its fundamental data, in its processes, and in its results. The mathematician shows that though his work may be full of pitfalls for the unwary, yet if ordinary precautions be taken his conquests in the realm of knowledge approach far more than those of any other science that ideal never reached, called certainty.

Of the data it is the stability rather than the precision that ought to be insisted on. For illustration, it will be sufficient to take just those instances which before were used to show the other side of the medal. It was pointed out that we can conceive an order of things in which the most fundamental of our notions of number were violated. But the very fact that, invariably, when the view is first presented to an educated man he naturally recoils, and only with reluctance admits the new idea, is due to a profound truth. Say to that same man that neither he nor anybody else can be legitimately certain that the sun will ever rise again, and he will cheerfully assent. He will probably add a remark, however, that the slightness of the probability of such an accident warrants him in performing all his actions to-day on the hypothesis that there will be a to-morrow. The stability of our belief that the sun will rise again is enormous. Similar, but perhaps in a much lower degree, is the stability of the belief that no new human being will appear except as the offspring of human parents. Deductions securely derived from such premises as these we expect with the most absolute confidence. But the stability of these beliefs, and therefore all results deduced from them, sinks into insignificance compared with the stability of the belief that there is a truth of nature underlying the statement that two and two always were and always will be the same thing as four. Perhaps reasons can be assigned for the overwhelming confidence that we have in such data as these which lie at the base of mathematics. It is sufficient for present purposes to place instances of the different kinds of universally held beliefs side by side and appeal to the instincts of my hearers. You are probably all prepared to acknowledge that there can be nothing known if we do not *know* that the word "four" or the word "thousand" really means something.

That other hackneyed illustration used above, our doubt as to the nature of the space in which we live, requires rather a different treatment. You will say that if it is now an open question whether or not Euclid's ideas of space are correct, surely Euclid's tyranny should be over, and every schoolboy ought to have a happy release. As a matter of fact, our scepticism on this point is much better educated than on that of the fundamental laws of number. As far as I am aware, nobody has yet investigated mathematically systems in which those laws do not hold. But with regard to space, several such systems have been investigated. Nevertheless, although we have no reason to suppose that our space belongs to one rather than another of such spaces, I unhesitatingly affirm that if measured by the standards of any science other than mathematics, our belief in the fact that our space is Euclidean has not received the slightest shock. By this I mean that we know that the properties of our space so closely approximate to those of Euclidean space that from a scientific point of view the question for or against Euclidean space is not a practical one. When not only all the living things on the earth live under one federal government, but when also all the living things in the solar system have united, and when we can, after due deliberation, guide for the good of the whole the solar system itself whither we will through space, when our commands of nature are such as these, we may expect the question possibly to become a practical one.

But let me not be misunderstood. I only say that, measured by the meaning of belief and knowledge in any other science, we *know* that our space is Euclidean. I may go further, and say that we are far more certain of this than of such well-established laws as those of gravitation and the conservation of matter. Only in this sense do I say that the question is not a practical scientific one. But looked at more generally by the inclusion of mathematics among the sciences, it becomes a most practical one. It is only because mathematics is so much more scientific than any other science that questions are raised in it of such transcendent interest. No other science has ever clearly stated and grasped the conditions of so far-reaching a question. Compared with this the question of the mode of evolution of worlds is a paltry problem.

Of the processes of mathematics the precision has grown to be a proverb. And were it not that perhaps for this very reason its significance is overlooked it need not even be mentioned here. To realise the vast importance of this precision, from a scientific point of view, we need only try to imagine the blessings that geologists would bestow on an apostle among them who should be able to render their own methods a tenth as precise. Not alone do scientists value this useful feature of mathematics. Even the scornful "practician," as Dr. Heavenside dubs him, recognises it, and is only too glad in the lower walks of mathematics to avail himself of it. The main reason why all sciences as soon as they are sufficiently developed look for aid to mathematics, is this valuable feature.

Turning now to the results of mathematics—I have said that these are also precise. But this must be interpreted with caution. So long as we deal with mathematics proper—*i.e.*, pure mathematics, the statement passes without any qualification. To other than mathematicians pure mathematics is so much an unknown region that I believe for the most part it is the applications of mathematics that are confounded with mathematics itself. This confounding of applied mathematics with mathematics proper is very analogous to the popular confounding of the applications of science to such purposes as electric traction and sanitation with science itself. There is an important distinction, however, which divests the confusion in mathematics of much of the harmfulness of the confusion in the other cases. For no scientific man holds that the application of science to sanitation is in itself science, however much a scientific training may be useful to those responsible for good sanitation. In this case, then, there is a popular misapprehension of what science really is. The applications of mathematics which we are now considering are on the other hand quite rightly regarded as a part of science rather than a part of the useful arts. This is owing, at any rate in part, to what has already been mentioned more than once, that mathematics possesses more exclusively than any other science what are regarded by all scientists as the essential characteristics of science.

The results in applied mathematics are in a sense not precise. They are exact only in proportion to the exactness of the data supplied. The mathematical part of the work is as precise as ever, but the part for which the mathematician is not responsible is not so.

The fundamental data that the astronomer hands over to the mathematician, from which he is to deduce far-reaching consequences, are confessedly but approximations—wonderfully close, it is true—and the deduced consequences are approximations of the same order. The approximations provided by the engineer are much less close, and the results deduced by the mathematician for the business of the engineer are corresponding.

But it is in this region of applied mathematics that mathematicians have rightly tried to impress the popular mind with the wondrous power of the science. Many books have been, are being, and will continue to be, written on this subject. And as the wealth of materials fully warrants this it would be but futile to do more here than make a passing allusion.

In conclusion, we may sum up the peculiar characteristics of the science of mathematics. It is unique in the cosmic nature and the universality of the questions it deals with, in the stability of the data on which it rests, in the reliableness of the assistance it renders to every other science which has become sufficiently highly generalised or sufficiently precise. It has been disputed whether mathematics is a branch of logic or logic a branch of mathematics. If we group them together for the moment we may say that they are further unique in the almost inconceivable exactness of their methods, and in their being exclusively an intellectual product as opposed to a combined intellectual and observational one. I am not prepared to defend the strict accuracy of this last distinction, but when you reflect on what is meant by observation and experiment in all the other sciences you will see that there is here a substantial difference.

It may be added that, notwithstanding this purely intellectual nature of the subject, notwithstanding the highly general nature of most of its results, the mere volume of these results, as in so many other sciences, is so great that it is impossible now for a single man to be really conversant with any but a small portion of the whole. The prospects opened up to the merely acquisitive mathematician, however great his powers in that direction, are far more than sufficient for his lifetime, whereas the inducements offered to him who would walk where no man walked before are only rendered the more numerous in that mathematics from its very extension provides more points of contact of the known and unknown than in any former age.

Section B.

CHEMISTRY.

ADDRESS BY THE PRESIDENT,

J. H. MAIDEN, F.L.S.

THE CHEMISTRY OF THE AUSTRALIAN INDIGENOUS VEGETATION.

CONTENTS.

INTRODUCTORY.

I propose to deal with the subject I have chosen for my discourse by endeavouring to answer the following questions:—

(1) What has been done in the direction of chemically investigating our indigenous plant products?

(2) What remains to be done?

(3) How can it best be done?

Firstly as to the workers. Those who are known by the generic and honourable term of chemists are readily divisible into two species, the "analytical chemist" and the "pharmaceutical chemist." The second species, either because he considers his designation too long, or because he is tired of association with the grand old science of chemistry, sometimes applies to himself a term in which the word chemist does not appear. Sometimes it happens that the two species are happily blended in the same individual.

The so-called analytical chemist (though, by the way, recent researches in organic chemistry have rendered it necessary that we should form a new species, or, at all events, a well-marked variety called the synthetical chemist), includes, in these colonies, individuals of widely-differing aims and qualifications. At present there is nothing to prevent a person calling himself an analytical chemist, and it is only within the last few years that Great Britain has taken steps to put the hall-mark on analytical chemists, a reform which will, I hope, take place here as a matter of course in a few years. There are sufficient analytical chemists in these colonies possessing the highest qualifications, who, if they took federal action in the way of instituting a system of examination and registration, could readily raise the standard of their profession. In the meantime I would suggest to analytical chemists that, by undertaking research work in connection with our indigenous vegetation, they have the means of setting the hall-mark on themselves, and in this work they will certainly win scientific *kudos*, and perhaps pecuniary advantage at the same time.

It is in the system of examination and registration already alluded to that the pharmaceutical chemist possesses such an advantage over his brother. I trust that the standard will continue to be raised instead of lowered, and these remarks are pertinent to the subject of my present address, because I believe that no body of men possesses such advantages for research in regard to the chemistry of our indigenous vegetation (and drugs in particular) as do pharmaceutical chemists. In them the sciences of chemistry and botany are happily blended; they are adepts at the methods for extracting the active principles of plants, and of applying reagents to them; they are in close touch with the physician, and are thus in a position to secure adequate therapeutic tests of the preparations they may make, or the active principles they may isolate. Here is a grand work truly, and every successful research by a pharmaceutical chemist adds lustre to the profession to which he belongs. The status of pharmaceutical chemists happily does not depend upon the caprice of governments or organisations; they have it in their own hands to raise their profession to as high a pinnacle of public respect and recognition as they choose. I again refer to this subject in my remarks introductory to "Drugs," as it is in this province or division of our indigenous vegetation that we hope to see the most brilliant achievements of the chemist.

In this connection I would like to make a practical suggestion. Having shown what special advantages pharmaceutical chemists have for this work, I would point out that individual action would be enormously strengthened by a federal bond. Can we not have, for the Australasian Group, an organisation corresponding to the British Pharmaceutical Conference? In the colonies we have fewer workers, and the distances are very much greater than in the old country; it seems, therefore, that an independent Australasian Pharmaceutical Conference would be an inordinate tax on the purses and time of pharmaceutical chemists. I would suggest (and I do it on my own responsibility) that our pharmaceutical brethren take advantage of the organisation already existing in the Australasian Association for the Advancement of Science. Would it not be well to form, say, a pharmaceutical sub-section? In this way chemists could, with a minimum of expense and trouble, be brought together to discuss scientific and intercolonial questions. A most important matter would be the compilation of a list corresponding to the Blue list of the British Pharmaceutical Conference. Some of the subjects of research I will indicate might perhaps be taken up, and individual members might undertake special items on the list, and so prevent important researches from being dealt with in a desultory manner or of being indefinitely postponed.

Queensland has always been fortunate in having distinguished workers in the domains of the chemistry and therapeutics of our native plants. The pride of place must be given to the pioneer work of our lamented friend Dr. Joseph Bancroft, to whose cordial greeting at this meeting many of us had looked forward. His son, Dr. T. L. Bancroft, has worthily followed in his father's footsteps, and already has to his credit a splendid record of work on the pharmacology of our native plants. The late Karl Theodore Staiger also did splendid work, and now we welcome Dr. Lauterer as a co-worker.

I speak to-day more from a chemical than a botanical standpoint, but in alluding to Queensland workers I surely must not omit reference to the economic work of the distinguished Colonial Botanist of the colony, Mr. F. M. Bailey, to whose name I would like to link that of Mr. John Shirley, an erudite lichenologist, and the indefatigable General Secretary for his colony of this Association.

I now proceed to discuss the various groups of Australian plant products.

HUMAN FOODS AND FOOD ADJUNCTS (INCLUDING MANNAS).

Our indigenous food-plants do not afford the chemist promise of great discoveries, but a number of them offer interesting research material to the student. Many of the fruits, &c., eaten by the aborigines are of varying degrees of unpalatableness and indigestibility, and proximate analyses might bring to light the causes of these flavours, while a chemical demonstration of their food value would be undoubtedly interesting. Such an investigation might indicate that some of these foods are more nutritious than they are at present supposed to be, and might be a handmaid to agriculture, by indicating plants whose products might be expected to be improved by cultivation.

The aborigines were almost omnivorous as regards vegetable products, but they had some staple (though very poor) foods, and I would like to see analyses made of them. Such are Munyeroo (*Portulaca oleracea*, Linn.), the small black seeds of which are largely used by the natives of the interior; the small fruits of the Native Melon (*Cucumis trigonus*, Roxb.), which are eaten in spite of their bitterness. They should be used with caution, and, like *Solanum* fruits, never eaten unless dead ripe. The matter is again referred to under "Drugs." The Nardoo (*Marsilea Drummondii*, A. Br.), which, after the expenditure of an utterly disproportionate amount of labour, yields a small quantity of dirty-looking flour.

An interesting field for investigation would be the starches of some of our food plants, particularly from the point of view of the microscopist. Take, for example, the seeds of the Moreton Bay chestnut (*Castanospermum australe*, A. Cunn.), *Macrozamia*, the roots of *Crinum*, *Blechnum serrulatum*, Rich. ("Bungwall"), which are but a selection from a very large number.

A large number of seeds, roots, &c., of our native plants, possess (like the pith of the sago palm) injurious properties unless they are washed or parched. Here is an extensive field for investigation, and among such plants, regularly used for food by the aborigines, may be mentioned the seeds of *Macrozamia*, *Castanospermum*, *Canavalia*, the tubers of Cunjevoi (*Colocasia macrorrhiza*, Schott) and *Amorphophallus viridis*, Blume (a virulently poisonous plant of the Northern Territory).

The acridity of the unripe fruits of many of our *Solanums* is worthy of inquiry. Some of them were eaten by the aborigines when dead ripe, and a chemical investigation of them at different stages of ripeness may be expected to be interesting.

We do not yet know the percentage of citric acid in the fruits of our various species of *Citrus* and *Atalantia*; neither do we know for certain the nature of the acid to which our native Tamarind (*Diploglottis Cunninghamii*, Hook, f.), the Queensland Cherry (*Antidesma*), the Cream of Tartar tree (*Adansonia Gregorii*, F. v. M.), the pulp which surrounds the seeds being acidulous; and the foliage of various species of *Hibiscus* owe their flavour.* The foliage of *Casuarina* is acidulous, so that chewing it often promotes a flow of saliva in the thirsty traveller; the acid is stated to be allied to citric acid, but this is surmise.

We know that several (perhaps all) of our sapotaceous plants including *Achras* and *Mimusops*, yield a milky sap which tastes like fresh cream. What food-value, if any, it possesses I know not, but in any case this substance undoubtedly presents a good deal of interest to the chemist. It could, however, only be conveniently examined where arrangements could be made for continuous fresh supplies. The milky juice of certain *Asclepiads* eaten by the aborigines has never been analysed.

A number of plants (usually from stern necessity) have been used by the inhabitants of this continent as substitutes for tea. I call to mind *Acæna sanguisorbæ*, Vahl., *Atherosperma moschata*, Labill., and *Doryphora Sassafras*, Endl., both known as sassafras; *Correa alba*, Andr., *Kennedya prostrata*, R. Br., *Kunzea Muelleri*, Benth., *Verticordia pennigera*, Endl., *Leptospermum scoparium*, Forst. (Captain Cook's tea), *Bæckia Gunniana*, Schau., *Myrtus acmenioides*, F. v. M. and *M. fragrantissima*, F. v. M. (the last two for flavouring), and *Ocimum sanctum*, Linn. The leaves were used in most cases, except those of the sassafrases, where the bark was employed. Most of the plants seem to have been chosen because of the essential oil they contain, and I am afraid that chemical examination is hardly likely to show that the plants contain valuable constituents.

Of true Spices we have very few that are likely to demand recognition. They include a so-called Native Ginger (*Alpinia cærulea*, Benth.). The fruits also of some of our native Umbellifers will probably repay the chemical investigator, as will the pungent seeds of our two species of *Drimys*.

The flowers of many Proteaceæ secrete nectar (honey) to such an extent that sufficient may be obtained from many species to permit an investigation into the sugars they contain.

Mannas.

Sandalwood manna (*Myoporum platycarpum*, R. Br.), has long been known as a food of the aborigines of the interior, and it has often been greedily sought after by Europeans. With the assistance

* Cf. Rennie, on the acids of the Native Currant (*Leptomeria acida*, R. Br.), Proc. Roy. Soc. N. S. W., xiv., 119.

of Mr. H. G. Smith, I have examined this manna, and find it to consist essentially of Mannite.*

Eucalyptus manna has, almost from the foundation of the colony, proved an object of interest, and for over half a century it has from time to time formed the subject of chemical investigation. The latest and most complete research was undertaken by Dr. Passmore in the Research Laboratory of the Pharmaceutical Society of London, and it was published (*Pharm. Journ.* [3], xxi., 717) under the title of "The Carbohydrates of Manna from *Eucalyptus Gunnii*, Hook., &c." The species from which manna is usually obtained is *E. viminalis;* and, having compared the mannas of the two species very carefully, I cannot find any difference between them. I therefore arrived at the conclusion that Dr. Passmore's valuable paper practically settles the matter of the composition of Eucalyptus manna. But a modern research on the chemistry of an allied body (Lerp), consisting of the sugary, lace-like coverings of certain Psyllideæ, is a desideratum. A valuable paper "On a new species of manna from New South Wales," by Thomas Anderson, is to be found in *The Edinburgh New Philosophical Journal*, Part II., p. 132 (July, 1849). This refers to Lerp. Flückiger has since published on the same subject (*Viertelj*, Wittstein, 1868, xvii., 161); see also Flückiger and Hanbury (*Histoire de Drogues*, ii., 59). Lerp is much more perishable even than manna, and the Australian chemist has therefore a great advantage over his European confrère in dealing with this substance. It is to be hoped, therefore, that the *kudos* pertaining to a thorough examination of it may fall to an Australian. In continental universities it is the practice to demand a thesis (embodying original reasearch) before a degree is conferred. I would like to see this excellent practice extended, at least as far as science degrees are concerned, in Australia. If for chemical students the condition were imposed of making the subject of the thesis a purely Australian one, I think a great step would be gained in the direction of getting done some of the enormous quantity of work awaiting the student in the domain of the chemistry of our indigenous vegetation.

Furthermore, it has rarely occurred to wealthy Australians (Sir Samuel Wilson and Sir W. J. Clarke, of Melbourne; the late Sir William Macleay, of Sydney; and Sir Thomas Elder and Mr. Horn, of Adelaide, are notable exceptions) to bestow part of their wealth on the furtherance of scientific investigation. The encouragement of chemical research into the properties of our native plants is, however, worthy of the support of all who have the intellectual and commercial development of these colonies at heart; and I have no doubt that, before long, the necessary funds will be forthcoming.

FUNGI.

It is only within recent years that serious steps have been taken to enumerate our Australian fungi, and the chemical work on these plants remains almost nil. One of the most interesting of them is what is known as the Native Bread or Truffle (*Polyporus Mylittæ*, C. et M.; syn., *Mylitta australis*, Berk.). It is, of course, largely used by our aborigines for food, and, owing to its gelatinous appearance, it was supposed to possess some food value, but I have

* Proc. R.S. S.A., xvi., 3.

shown* that this is founded on a misapprehension, as it consists of a form of cellulose, most probably fungin. It would also be interesting to know the composition of *Hirneola*, so largely exported to China for use in soups under the name of "fungus." A chemist desirous of undertaking a research might turn his attention to *Cyttaria* and many others of our interesting fungi.

ALGÆ.

Apart from the purely scientific aspect of the question, when we recollect how in various parts of the world seaweeds are largely used for fertilising the soil and also for human food, it is perhaps an oversight that none of our seaweeds have been analysed by the chemist. Some of our algæ might reasonably be expected to form efficient substitutes for Iceland and Irish moss. One of them (a variety of the cosmopolitan *Gracillaria confervoides*, Grev.) has been so used in Tasmania for many years, and I found it to contain pararabin.

Reports have from time to time been made in regard to cattle alleged to have been poisoned by drinking water charged with poisonous algæ at Lake Alexandrina, South Australia. The late Mr. F. S. Crawford states the case in the *Garden and Field* (Adelaide), November, 1889, p. 62, and it may be the work of the chemist to endeavour to clear up the matter.

GRASSES.

Very few analyses have been made of our indigenous grasses, but it is very desirable that a comprehensive investigation of them should be carried out. To do the work properly we require specimens of the same species collected in different parts of Australia, in different seasons, and in different stages of growth. In order to secure strictly comparable results it would be desirable to set apart one chemist, whose attention should not be distracted with any other kind of work. He could do the work with reasonable thoroughness in three years, and his researches would settle the comparative value of many of our esteemed indigenous grasses, and also give us specific information in regard to the value of some grasses in respect to which we only possess vague information. If, in addition, we could obtain analyses of introduced grasses grown in the colonies, the results would be of enhanced value.

SALT BUSHES AND OTHER FODDER-PLANTS.

The valuable fodder-plants known as salt bushes (Chenopodiaceæ) form a well-defined group which should be uniformly dealt with by a chemist, as suggested in the case of grasses. Mr. W. A. Dixon has given analyses of a few,† but the time has arrived for a more comprehensive research. It would also be desirable to systematically undertake the analysis of some of the numerous indigenous shrubs which, through choice or necessity, form part of the food of the flocks and herds of Australia.

An alkaloid (Chenopodine), crystallising in microscopic crystals, and possessing a noxious odour, has been found by Reinsch‡ in *Chenopodium album*, Linn. It might be looked for in our indigenous species.

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* Agric. Gazette N.S.W., iv., 910 (1893). † Proc. R.S. N.S.W., xiv., 133.
‡ N. Jahrb. Pharm., xx., 268, and xxvii., 193.

PLANTS POISONOUS TO STOCK.

The matter of stock-poisons is one of very serious moment to the pastoralists and graziers of Australia. The mortality of stock is often increased by reason of the impossibility of isolating either them or suspected plants—a thing comparatively easy in a country well hedged or well fenced. It would appear that, on the subject of stock maladies, two schools are being differentiated in Australia: those who accuse plants of being the cause of nearly every ill from which stock suffer, and those who almost ignore plants in the matter, fixing the blame on microscopic organisms (bacteria, etc.).

Mr. Edward Stanley, Government Veterinarian of New South Wales, is the chief exponent of what I may, for brevity, term the anti-poison plant theory. He has experimented on sheep with *Euphorbia Drummondii*,* a plant that thousands of people still firmly hold to be poisonous. Mr. Stanley concludes that stock which perish through eating this plant die either from indigestion or from diseases such as anthrax. I believe that analysis has thrown no light on the effects of this plant. Other Euphorbiaceous plants reported to be poisonous are *Beyeria viscosa*, Miq., *Phyllanthus lacunarius*, F. v. M., and *Omalanthus (Carumbium) populifolius*, Grah., none of which have been chemically investigated so far as I am aware.

It is not often that one now hears of a new poison-plant, a few being usually accused of destroying sheep, cattle, and horses with painful iteration. Among such are the *Euphorbia* already alluded to, *Swainsona Greyana*, *galegifolia*, &c. (Darling Pea), *Nicotiana suaveolens*, Lehm. (Native Tobacco), *Bulbine bulbosa*, Haw. (Wild Onion). Such plants are, therefore, popularly known as stock-poisons.

That the death of many animals is directly traceable to such plants is open to no doubt. They are, therefore, "stock-killers," and it is rather a reflection upon us that we do not yet know whether some of them are true "stock-poisons" or not. Nevertheless, the stock authorities of the various colonies will do well to continue to disseminate information in regard to them by means of pictorial illustration or otherwise. The average stockowner simply requires to be put on his guard in respect to such plants, for, if it be established that they destroy his stock, he looks upon it as a mere quibble by what agency they effect their fell purpose by alkaloids, by proteids, or by acute indigestion. The matter of poisonous fodder-plants is still *sub judice*, if I may use the expression. Chemists both in Australia and Western North America (where the same problems as regards such poisons have to be dealt with) are working at this very difficult subject. Investigations of this character can only be satisfactorily undertaken by the co-operation of the chemist with the animal physiologist. Some of the poisons may be of a proteid character; and if so, the difficulties of any investigation would be considerably increased. It would be an advantage to the chemist to be acquainted with methods of bacteriological study.

The chief interest in regard to poisonous fodder-plants in Australia centres around the Leguminosæ. The very mention of the Darling Pea awakens painful associations amongst pastoralists. *Crotalaria Mitchelli*, Benth., is accused of similarly dangerous

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* Agric. Gazette N.S.W., i., 18, 1890.

properties. *Gastrolobiums*, both in Western Australia and Queensland, have been the cause of the death of a very large number of sheep for many years past. Species of *Oxylobium* and *Tephrosia* are also in bad repute. Rummel* finds a glucoside (Gastrolobin) in *Gastrolobium bilobum*—the Heart-leaf poison bush of Western Australia. It is hygroscopic, and has a saffron odour. Guthrie† has examined *Swainsonia galegifolia*, R. Br., and finds that the only substance contained in it likely to be poisonous is an oily body extracted by alcohol. I understand that he is continuing his experiments.

I know no subject in the whole range of stock-poisons that is calculated to bring more *kudos* to the chemist than an investigation of this group. The question may be truly said to be a burning one.

The disease known as "rickets" (not rachitis) or "wobbles," has been a source of great loss to stock-owners for many years past. In Queensland Dr. T. L. Bancroft has investigated the subject, but the most recent and ample report‡ is that by Mr. H. H. Edwards, Government Veterinary Surgeon of Western Australia, in which that gentleman, confirming the observation that the disease is owing to the eating of *Macrozamia* plants, gives a full account of the disease and its effects, and suggests remedies. A thorough chemical investigation remains, however, a desideratum, and the toxic substance will probably prove to be a proteid. Until we can isolate and examine these toxic principles, our treatment of animals which have assimilated them must necessarily be more or less of an empirical character.

Complaints are made in New South Wales that cattle eating the young shoots of *Xanthorrhœa* (Grass-tree) are affected in a somewhat similar manner to animals which have eaten *Macrozamia*. The plants might be studied simultaneously.

Other real or supposed stock-poisons worthy of investigation by the chemist are *Stypandra glauca*, R. Br., which bears a bad name in Western Australia; *Pimelea hæmatostachya*, F. v. M., and perhaps *P. trichostachya*, Lindl.; several plants belonging to the Campanulaceæ (*Isotoma*, *Lobelia*), and perhaps some *Velleias* (Goodeniaceæ). This does not, of course, by any means exhaust the reputed poisonous plants of Australia frequently eaten by stock. *Gratiola officinalis* is said to poison cattle in Swiss pastures; our species of *Gratiola* should, therefore, be kept in view.

In this connection the matter of indigenous plant-vermifuges for stock is worthy of the chemist's attention. Species of *Boronia*, *Frenela* (*Callitris*), *Zygophyllum*, and the ripe fruits of *Petalostigma quadriloculare*, F. v. M., have been used amongst others. The chemist could decide whether they are of real use or not.

SUBSTANCES REPUTED MEDICINAL—DRUGS.

At one time a drug and a nauseating substance were convertible terms, and hence it has come about that anything in our indigenous vegetation of a particularly nasty flavour has had medicinal properties ascribed to it. The number of such plants is very large indeed, and it has been the work of scientific men to considerably reduce the list. What the ultimate result of investigations in this direction will be, no

* J. Chim. Min., 1880, 1032. † Agric. Gaz. N.S.W., iv., 86 (1893)
‡ Journ. Bureau Agric. W.A., i., 225 (27th Nov., 1894).

one can tell; we are, in fact, only on the threshold of accurate research, but at present we must admit that the number of indigenous plants proved to possess really valuable properties capable of replacing articles in the Pharmacopœia, or of filling a gap not yet filled by any other article of *materia medica*, is very small indeed. I do not, however, wish to be thought to express an opinion that there is no prospect of a harvest in this field. The imperfect list of suggestions I shall venture to bring under your notice will be sufficient to show that the ground has been merely scratched, and frequently there appears to us some fresh plant whose chemical and therapeutical investigation seems desirable. Negative evidence is of value; and if only the research chemist can show that the claim of some of our reputed drugs rests on no scientific basis, a great step will have been made in the direction of clearing the path of encumbrance. But I believe that our indigenous plant substances require only to be carefully investigated to reveal really useful drugs. In referring to this matter one feels like the voice of one crying in the wilderness. The men in Australia who have up to the present shown the necessary inclination and knowledge to carry through such investigations to finality are very few indeed, and they are mostly weighted down with teaching and other duties. One good way, it seems to me, of advancing this work, would be to establish a system of research scholarships tenable in the laboratories of men who have specialised in work of this kind. I am inclined to think that scholarships of very reasonable amount would permit students to extend their time at a university, school of pharmacy, or technical college for research work only. If in any of the colonies there could be established a research laboratory somewhat on the lines of that in connection with the Pharmaceutical Society of Great Britain, it would be a good thing; but, whatever the agency for doing the work, there is no doubt that we should, in Australia, have some organised means of investigating our reputed medicinal plants. I think we could be mainly independent of Governments in this matter; at the most we might ask for a subsidy proportionate to the amount of public subscriptions or benefactions. I would cordially invite members of this Association to consider the matter, for I feel sure that the principal reason why more has not been done in the past is because the subject has to some extent been lost sight of.

The Royal Society of New South Wales, by means of medals and money prizes, has done much to stimulate research, and if the necessary funds were forthcoming this Association (like the parent British Association) might do good in a similar way.

Just a whisper to high-souled Australians. Our educational advantages are most liberal—one might say lavish. Has the time not yet arrived when we should compete with the scientific men of Europe for the privilege of investigating our own plant products? I would like to see our research work in the domain of our indigenous vegetation to be at least as successful as our cricket. Intellectual victors may not be applauded so vociferously as our heroes of athletics, but there is nothing in the world (other than a kind act) which causes the doer such happiness in the doing as research work.

Last year the British Government communicated with the various Australian Governments on the subject of proposed additions and amendments to the forthcoming Pharmacopœia. The notes I am about to submit show the state of our knowledge in regard to the various reputed drugs of Australian indigenous growth. It must be at once confessed that, with the exception of eucalyptus oil (dealt with under a separate heading), either our plant products have not been worked at with that exhaustiveness, and to that finality, which are necessary for the inclusion of any drug in the Pharmacopœia, or, having been thoroughly investigated, are found not to be really valuable additions to (or substitutions for) the present pharmacopœial drugs. An officinal drug must maintain its position by its own merits. Its position is always liable to be challenged, and, like an elected member of a legislature, it is always liable to lose its place to a substance which has obtained the suffrages of medical men. No amount of sentiment or special pleading will by themselves secure the inclusion of any native drug on the official list. We should therefore go steadily on investigating our native plants, isolating active principles, and subjecting them and the crude drugs to therapeutic tests. If any of our plants are proved to possess merit, they cannot be prevented from exercising their usefulness, and when the next opportunity for revision occurs, we may proudly offer our contribution to the Pharmacopœia of the Empire.

I now proceed to arrange the drugs in natural orders, and the orders in botanical sequence, hoping that this will be useful to the student. As a matter of convenience I have included in the list certain plants which have formed, or should form, the subject of chemical investigation for active principles, whether the principles may or may not be likely to possess therapeutic value.

Magnoliaceæ.—We have two species of *Drimys (D. aromatica*, F. v. M., and *D. dipetala*, F. v. M.). It is probable that one or both possess properties analogous to Winter's bark (*D. Winteri*, Forst). The matter is worth investigation. The latest research on the bark of *D. Winteri* is by Arata and Canzoneri.*

Menispermaceæ.—Dr. T. L. Bancroft† has partially examined *Pericampylus incanus*, Miers.; *Sarcopetalum Harveyanum*, F. v. M., and *Stephania hernandiæfolia*, Walp., and his physiological experiments on frogs with extracts of the plants are full of interest. Rennie and E. F. Turner‡ have found picrotoxin or a mixture of that substance and picrotoxinin in the roots of the *Stephania*. *Anamirta cocculus* berries (known in commerce as *Cocculus indicus*) contain quite a number of alkaloids and bitter principles, and a chemical investigation of our Menispermaceæ might perhaps include their fruits.

Malvaceæ.—A further examination of the bark of *Adansonia Gregorii*, F. v. M., the Australian Baobab, in which (as also in *A. digitata*), Wittstein§ found adansonine (?an alkaloid) would appear to be desirable.

Rutaceæ.—A very interesting genus, both to the chemist and physiologist, is *Xanthoxylon*. *X. fraxineum*, Willd., is the Prickly Ash of North America, which is officinal in the U. S. Pharmacopœia. The alkaloid (xanthoxyline) it contains is stated to be identical with

* Gazetta, xviii., 527; Journ. Chem. Soc., lviii., 405.
† Proc. Linn. Soc. N.S.W., 2, iv., 1063 (1889); Proc. R.S. Qd., viii. (1890).
‡ Proc. R.S. S.A., xvii., 186.
§ Viertelj. schr. f. Pharm., iv., 41; also "Organic Constituents of Plants (Mueller's trans.), p. 6.

berberine. In Artar root (*X senegalense*, DC.), Giacosa has found an interesting alkaloid called artarine. Indian species are used in medicine, and their chemistry is dealt with in the *Pharmacographia indica*, i., 258.

To Dr. T. L. Bancroft,* however, belongs the credit of first inquiring into the physiological effects of an Australian *Xanthoxylon*, *X. veneficum*, Bail. "The action it causes, when injected into warm-blooded animals, seems much like that of strychnine; yet upon frogs it does not cause tetanus." I trust these investigations will be continued, and with the co-operation of a chemist who will undertake to make a complete analysis of the bark. Dr. Bancroft also draws attention to the properties of the bark of *Melicope erythrococca*, Benth.,† allied to *Xanthoxylon*.

Olacineæ.—The late Sir William Macarthur pointed out nearly forty years ago that the bark of *Villaresia Moorei*, F. v. M., contains a peculiar and little-known bitter principle. What is it?

Leguminosæ.—The bark of *Acacia tenerrima*, Jungh., contains, according to Greshoff,‡ a bitter poisonous alkaloid, readily soluble in ether and chloroform. No alkaloid has been previously found in an Acacia, and the discovery should stimulate Australian chemists to further investigations on our own barks, as the bitterness of those already examined for bitter principles has hitherto always been ascribed to a saponin.

The Sennas of the Pharmacopœia consist of the leaflets of two species of *Cassia*, which owe their properties mainly to the presence of a glucoside acid called cathartic acid. We have several species of *Cassia*, and it might be seen whether any of them possess purgative properties. Such an investigation might very readily be carried out by a pharmaceutical chemist.

The leaves of various species of *Daviesia* (and particularly *D. latifolia*, R. Br.) are so intensely bitter as to have earned the name of Native Hops. They have long been used medicinally in various ways by country people, yet their active principle has never been isolated. This is another research that could readily be undertaken by a country pharmaceutical chemist.

The roots and even leaves of the common purple-flowered *Hardenbergia monophylla*, Benth., are commonly but wrongly known as Native Sarsaparilla, and they are often used as a substitute for the true colonial Sarsaparilla (*Smilax glycyphylla*, Sm.). The impression that *Hardenbergia* is a valuable medicine is, however, so widespread, that it would appear desirable to make a chemical investigation of the plant to see if there is any scientific foundation for the belief. Rennie§ and Alder-Wright find the glucoside glycyphyllin in *Smilax glycyphylla*. Acids convert the glucoside into phloretin and isodulcite.

Rosaceæ.—Buchner‖ has incompletely examined *Geum urbanum*, Linn., a European and Australian plant. He finds it to contain

* Proc. R.S. N.S.W, xx., 70 (1886); Proc. Intercol. Med. Cong., ii. (Melbourne, 1890).
† Proc. R.S. Qd., vii. (1890).
‡ Ber., xxiii., 3537; Journ. Chem. Soc., lx., 336.
§ Proc. R.S. N.S.W., xx., 213; Journ. Chem. Soc., xxxix., 237, xlix., 857.
‖ Repert. Pharm., lxxxv., 184.

an amorphous neutral, yellow, bitter principle. This investigation might be followed up on this species, and also on the Tasmanian *G. renifolium*, F. v. M.

Cucurbitaceæ.—Fortunately cases of poisoning of human beings by indigenous plants are very rare. The Native Melon (*Cucumis trigonus*, Roxb.) is an exception; and Dr. J. Francis Souter narrated, in the *Australasian Medical Gazette*, an instance of the poisoning of a child of three, which was happily followed by recovery under the practitioner's care. The chemical composition of this fruit has (as far as Indian-grown specimens are concerned) been partially examined by Dymock, Warden, and Hooper,* but no case of poisoning in that country appears to have been traced to the plant. It certainly is worthy of further investigation. *Lagenaria vulgaris*, Ser., is also poisonous. *Luffa ægyptiaca*, Mill., var. *peramara*, Bail., the Queensland representative of the Towel-gourd, has a fruit which Dr. T. L. Bancroft describes as intensely bitter to the taste. In a few minutes the taste disappears, but leaves a distressing acridity in the throat, which is not at its worst until several hours afterwards. He also states that an extract is very poisonous, and contains two principles—a bitter substance and a saponin. This interesting research has not been completed, and I would suggest that a chemist isolate these two principles.

Cornaceæ.—Dr. T. L. Bancroft reports that he has found in *Marlea vitiensis*, Benth., an alkaloid which, however, he has failed to crystallise. He reports that it is probably not emetine, "although it probably belongs to the group of poisons of which emetine is the type."† I would invite the attention of the chemist to this plant.

Rubiaceæ—Search might be instituted for plants which contain emetine. The best known plant which contains it is of course *Cephaëlis ipecacuanha*, DC., a Rubiaceous plant; while the so-called Striated Ipecacuanha (*Psychotria emetica*, Mutis) also contains it. The roots of our species of *Psychotria* (some of which are exceedingly abundant) might well be examined for emetine, and the investigation might profitably be extended to others of our indigenous Rubiaceæ.

A plant yielding a popular "bitter" is the Leichhardt Tree (*Sarcocephalus cordatus*, Miq.). It is found in Asia and the Pacific Islands, as well as in Queensland; but its bitter principle has never, so far as I can learn, attracted the attention of the chemist. Dr. T. L. Bancroft‡ deprecates its use as a substitute for quinine. Mr. N. Holtze suggests that the wood would make excellent "bitter-cups."

Sapotaceæ.—Some years ago, at the instigation of the late Dr. Joseph Bancroft, Mr. Staiger analysed the bark of *Achras laurifolia*, F. v. M., and found it to yield 30 per cent. of extract (containing glycyrrhizin), and 12 per cent. of tannin. He accordingly suggested its use for throat lozenges. A thorough chemical examination of the barks of other indigenous species of *Achras* (and particularly *A. australis*, R. Br.) might be undertaken. A sample of the bark

* Pharmacographia Indica, ii., 66.
† Proc. Linn. Soc. N.S.W. [2], iv., 1062.
‡ "Research into the Pharmacology of some Queensland Plants." Christchurch, N.Z., 1888.

of *A. laurifolia*, F. v. M., from the Illawarra, contains 8·25 per cent. of tannic acid, and 26·35 per cent. of extract, which, through inadvertence, was not examined for glycyrrhizin.

Michaud has found a glucoside (sapotin) in the kernels of *Achras Sapota.* This substance may be looked for in the kernels of our species of *Achras*, *Lucuma*, and other Sapotaceæ.

Jasmineæ.—Chionanthus picrophloia, F. v. M., has an intensely bitter bark, which has been used as a febrifuge, though what claim it has to that character appears to be unknown.

Apocyneæ.—Alstonia constricta, F. v. M., first brought into notice for its medicinal properties by the late Dr. Joseph Bancroft, has not outlived its reputation. Its bark is remarkable for the number of alkaloids found in it, and for a number of years has been investigated by a number of chemists, particularly Hesse. The last work on it is by Merck (*Bulletin*, i., 5), who has re-examined alstonine. There is no doubt that the bark is a useful antiperiodic, antiseptic, and stimulant, uniting in some measure the properties of quinine and strychnine.

A well-known poisonous tree of India and the Malay Archipelago, and also indigenous to Queensland and Northern Australia, is *Cerbera Odollam*, Gærtn. The nut is poisonous, and the bark is purgative, but only recently has this interesting plant been investigated chemically. Greshoff* finds that the sap, leaves, and bark have no toxic action, but the seed-kernel contains, in addition to a non-poisonous fatty oil, the substance cerberin, which has a poisonous action on the heart. He also gives an account of his chemical examination of cerberin.

The timber and bark of *Ochrosia Moorei*, F. v. M., a plant of New South Wales, are intensely bitter, and are well worthy of chemical investigation. Greshoff has found a crystalline, colourless, moderately poisonous alkaloid, soluble in ether, in various Javanese *Ochrosias*—viz., *O. acuminata*, *ackeringæ*, and *coccinea*.

The bark of *Tabernæmontana orientalis*, R. Br., is intensely bitter, and it has therefore been used for very many years as a tonic in country districts. Some time ago Dr. T. L. Bancroft made some preliminary experiments with it, and informed me that it is physiologically inert, or practically so. Since then Greshoff* has been examining *T. sphaerocarpa*, Bl., from Java, and finds that it contains an alkaloid and a wax-like compound which is free from nitrogen, and which melts at 185 degrees. In view of this it may be desirable to subject *T. orientalis* to chemical analysis.

Asclepidaceæ.—An Asiatic species of *Tylophora* (*T. asthmatica*, W. et Arn.) has for many years been used in India and the Mauritius as a substitute for ipecacuanha, both root and leaves being employed. It is a really valuable medicine, and it is included in the pharmacopœia of India (see Waring, p. 142), and an account of the plant may be found in Bentley and Trimen's "Medicinal Plants," No. 177. Hooper† has found it contains an emetic alkaloid, which he calls tylophorine, and this substance might well be sought for in our numerous *Tylophoras*, and in perhaps some of our Marsdenias.

* Ber., xxxiii., 3537; Journ. Chem. Soc., lx., 337. † Pharm. Journ. [3], xxi., 617.

Gentianeæ.—The pretty pink-flowered Native Centaury, found in grass-lands abundantly in all the colonies, is *Erythræa australis*, R. Br., considered by Bentham and Mueller to be identical with the European *E. spicata*, Pers. Considering the natural order to which it belongs, its bitterness is not a matter of surprise. Of all native plants it is one of the most universally used for liver complaints, diarrhœa, &c.; and it is not generally known (if I may so assume from the inquiries that have been addressed to me) that it has been chemically examined by Méhu* and other chemists. It contains a glucoside, to which the name of erythrocentaurin has been given.

Solaneæ.—Dr. T. L. Bancroft has shown that an extract of the leaves of *Solanum aviculare*, Forst., does not dilate the pupil, but is poisonous, probably because they contain nicotine. He has also partially examined *S. verbascifolium*, Ait. The name of the late Dr. Joseph Bancroft will ever be remembered here by his researches on Pituri (*Duboisia Hopwoodii*, F. v. M.), *Anthocercis*, and other Solanaceous plants, but only the two *Duboisias* may be said now to have been thoroughly worked out. There is therefore much work to be done in regard to the chemical examination of our indigenous Solanaceæ, and such a research would be most uniformly and expeditiously done if a research student were enabled to devote his undivided attention to it for a lengthened period. As a model, I would here refer to Professor Liversidge's investigation of pituri.† Some work has already been done with *Anthocercis*, and a comprehensive examination of this fairly large genus might therefore be undertaken early. *Anthotroche*, and the genera *Lycium*, *Datura*, and *Isandra*, represented in Australia each by one species, also await the investigator.

Duboisia myoporoides, R. Br., is another of Dr. Joseph Bancroft's drugs. What Hesse has done for *Alstonia constricta*, Ladenburg has done for the present species. The value of the plant has been discounted of recent years by the discovery that the principal alkaloid it contains (duboisine) is isomeric with atropine. The leaves are nevertheless of much interest, and have by no means been fully worked out by either the chemist or the therapeutist. Merck‡ has discovered in *D. myoporoides* a new alkaloid, pseudhyoscyamine, and is, I understand, continuing his investigations. Duboisine is identical with hyoscyamine, and according to Schmidt, commercial duboisine is frequently only scopolamine (hyoscine).

Scrophularineæ.—The plants known in these colonies as Brooklime are *Gratiola pedunculata*, R. Br., and *G. peruviana*, Linn., and in Eastern Australia, in the country districts, they are coming increasingly into use for liver complaints, for which they appear to give satisfaction, the only complaint made being that a decoction is inclined to gripe. I trust that these plants, which frequent damp situations, and which are exceedingly plentiful in some places, will be carefully investigated. An allied species (*G. officinalis*) is, like our plants, a bitter purgative and emetic; but it is even poisonous in large doses. It is stated that the plant is so abundant in some Swiss

* Journ. de Pharm. [4], iii., 265; Pharm. Journ. [3], i., 990; Hist. de Drogues (Flückiger et Hanbury), ii., 104.

† Proc. Roy. Soc. N.S.W.

‡ 1892, Bericht, p. ii.; Phar. Journ. [3], xxiii, 606.

meadows that it is dangerous to allow stock to graze in them. The plant has been investigated by Walz,* who finds its active principle to be a bitter glucoside, which he has termed gratiolin. It is poisonous, slowing the heart's action. In view of this, I would recommend our species of *Gratiola* to be used with caution.

Verbenaceæ.—Mr. F. M. Bailey reports that the Javanese on the Johnstone River, Queensland, used the bark of *Callicarpa longifolia*, Linn., as a substitute for betel leaf in chewing betel-nut. I know of no *Callicarpa* which has been chemically examined. *C. longifolia* may therefore, perhaps, be taken in hand, although the Natural Order is not one from which much may be expected.

Phytolacceæ.—The bark of *Codonocarpus cotinifolius*, F. v. M., contains a peculiar bitter, and perhaps possesses medicinal properties. The bark is smooth, and, when quite fresh, of a pinkish colour. The leaves resemble horse-radish or turnips in taste. Although often known as Quinine-tree, the taste is quite distinct from quinine. In describing another species (*C. australis*), Hooker† says—"While dissecting the flowers and fruit, they were found to diffuse a most powerful smell, resembling that of ether." It might be desirable to subject plants of this genus to chemical examination.

Monimiaceæ.—The so-called Tasmanian and Victorian Sassafras (*Atherosperma moschata*, Labill.), which has for many years been used as a bush remedy, and which has been tried as a remedy in heart disease, must, according to Stockman,‡ be removed from the list of really useful medicinal substances. It will be sufficient to refer to his paper and his conclusions at the close.

A plant which is worthy of thorough investigation by the chemist is *Daphnandra repandula*, F. v. M., which, perhaps, contains more than one alkaloid. Dr. T. L. Bancroft has used a tincture of the bark of this species and also of *D. micrantha*, Benth., in heart disease. His observations§ are mostly of a physiological nature, and it is highly desirable that the active principles which have produced the effects described should be isolated.

A plant which promises to be of interest to the chemist is the imperfectly known *Piptocalyx Moorei*, Oliv., which is provisionally referred to the same Natural Order. It is a climbing plant with inconspicuous flowers, found in the mountain ranges between Grafton and Armidale, New South Wales, where it is known as Bitter-vine. It may be, and I trust will prove to be, quite harmless, but inasmuch as trial shipments have been made to Europe to test its value as a hop substitute, we require to know beyond doubt what its physiological effects are. Mr. J. C. Umney has the plant in hand, and has found a bitter crystallisable substance in it of a glucosidal character, and we await with interest the conclusion of his experiments.

Laurineæ.—The recent researches of Greshoff‖ on the barks of some Javanese species, and the discovery in them of an alkaloid

* Jahrb. Pharm., xiv., xxi., xxiv.; N. Jahrb. Pharm., x.

† Bot. Miscell., i., 245.

‡ "On the Action of the Volatile Oil of *Atherosperma moschata*"—Pharm. Journ. [3], xxiii., 512.

§ Proc. R.S. N.S.W., xx., 69 (1886); Proc. R.S. Qd., v. (1887); Trans. Intercol. Med. Congress, ii. (Melbourne, 1890).

‖ Ber., xxiii., 3537; Journ. Chem. Soc., lx., 337.

(laurotetanine) possessing tetanic action on animals, should stimulate our chemists to a thorough investigation of some of the undoubtedly interesting Australian species belonging to this Natural Order. The alkaloid is contained in quantity in the bark of *Litsea chrysocoma*, Bl., a reason why early attention should be directed to our *Litseas*, but I have no doubt other allied genera will amply repay investigation.

A plant to which Dr. T. L. Bancroft has given a good deal of attention is *Cryptocarya australis*, Benth. The bark is persistently bitter, said to be due to the presence of an alkaloid which crystallises from its solution in stellate masses of acicular crystals, and which is believed to closely resemble curarine. I refer to Dr. Bancroft's papers themselves,* and would only remark that he has made out a strong *primâ facie* case for a thorough chemical examination of the bark, which will probably bring *kudos* to the chemist who undertakes it. Our other *Cryptocarya* barks should, in my opinion, be examined at the same time.

Euphorbiaceæ.—M. Ottow has found in *Phyllanthus Nurri*, from Java, an intensely bitter, poisonous principle called phyllanthin. *Phyllanthus* is so common in Australia, both as regards species and individuals, that the substance might be further investigated by an Australian student. A bitter neutral principle called pseudochiratin was found by Dymock, Warden, and Hooper† in an Indian *Phyllanthus*.

Another plant yielding a bitter bark, often used as a tonic by people in New South Wales and Queensland, is *Petalostigma quadriloculare*, F. v. M. Falco‡ many years ago found it to contain "a camphoroidal essential oil, and an indifferent bitter principle belonging to the glucosides." Dr. Joseph Bancroft stated that its bitterness is due to a peculiar tannin. Dr. T. L. Bancroft informed me that it is physiologically inert, or practically so. It would be well to have the bark carefully analysed, and the result would probably be interesting. The kernels should also be examined. A correspondent regularly uses them, saying they form one of the best tonics he knows of.

Piperaceæ.—We are indebted to the late Dr. Joseph Bancroft for drawing attention to the gigantic Native Pepper-vine (*Piper Novæ-Hollandiæ*, Miq.), from a therapeutic point of view. His son (Dr. T. L. Bancroft), continuing his father's experiments, cautiously says he has "not made sufficient advances to speak of it as a valuable drug for any particular purpose." I believe it to be the case that the plant has not been subjected to chemical investigation, an omission I trust will be remedied before long.

NARCOTICS.

I have no recent work to report in connection with the principal narcotic of the aborigines—viz., pituri (*Duboisia Hopwoodii*, F. v. M). Liversidge's research, alluded to under "Drugs," remains the most recent one, and is all but exhaustive. Langley and Dickinson§ have

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* Proc. R.S. Qd., iv. (1887): "Research into Pharmacology of some Queensland Plants" (1888)—Trans. Intercol. Med. Cong., 1890.

† Pharmacographia Indica., vi., 267.

‡ Watts' Dict., vi., 1st Suppl., 904.

§ "The Physiological Action of Pituri and Nicotine"—Journ. Physiol., xi., 265.

shown that the physiological action of pituri is identical with that of nicotine.

Hedley* states that the Port Curtis blacks dry and smoke the leaves of *Adriana acerifolia*, Hook, a Euphorbiaceous plant, as a substitute for tobacco; and Mr. Nicholas Holtze informs me that the Daly River blacks smoke the leaves of *Amorphophallus variabilis*, Blume, in the Northern Territory. Both of these plants await the attention of the chemist.

Our common Native Tobacco (*Nicotiana suaveolens*, Lehm.), although possessing the same physiological action as ordinary smoking tobacco, appears never to have been used by the blacks. It could not be conveniently used for smoking purposes, as the leaves have no substance, and fall to powder when dry. I would suggest that this species be subjected to a complete analysis by the chemist.

FISH POISONS OF THE ABORIGINES.

I would suggest to chemists the propriety of investigating the various plants which have been employed by the aborigines in different parts of this continent for throwing in rivers or waterholes for the purpose of stupefying fish so that they may be readily caught. I have enumerated a number of them in a recent article† on the subject to which I venture to refer my hearers.

GUMS.

The difficulty in procuring samples of many gums, resins, and kinos is enhanced by their capricious exudation, and the rapidity with which they are affected by the rain and other atmospheric influences. It is also often very difficult to authenticate material, which sometimes becomes useless to the experimenter for that reason. Some gums, &c., exude in very small quantities, so that the patience of the investigator is sorely tried. I have numbers of such substances varying in weight from only a few grains to an ounce, of which I have been unsuccessfully endeavouring for years to collect additional quantities for research.

Wattle gums, the products of the genus *Acacia*, so very largely developed in Australia, form a regular article of export to Europe. Those from the interior (climatically like the deserts of Egypt) are, comparatively, light-coloured and soluble; those from the well-watered coast and mountain districts are more insoluble (some merely swelling up in water), and often dark-coloured. The gum-yielding species are very numerous, so the variability in composition and appearance is readily accounted for. The gum of *Acacia dealbata*, which with us is usually rather insoluble, yields in Java (presumably from cultivated trees) a soluble gum, on the authority of Dr. de Vrij.‡ Gum of the same species grown in France, and examined by Heckel and Schlagdenhauffen§, is also more soluble than with us, thus indicating that changes in gums may be brought about by cultivation of the plants yielding them. In the present instance the matter is important, as the greater the solubility in water the greater the commercial value.

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* Proc. R.S. Qd., v. p. 13.
† Agric. Gazette N.S.W., v., 470 (July, 1894).
‡ Chem. and Drugg., 20th August, 1892, p. 260.
§ Le Naturaliste, 1st July, 1890, p. 151.

I have published analyses of a large number of *Acacia* gums; but there are a large number of others yet to be identified and examined, as gums of this kind are usually mixed together by collectors. While speaking of this genus, we know nothing of the composition of the clammy substance (probably resinous) found on the leaves of *A. verniciflua*, A. Cunn. (syn. *A. exudans*, Lindl.), and first remarked upon by Sir Thomas Mitchell.

I will refer to a few other leguminous gums in alphabetical order of genera. *Adenanthera pavonina*, Linn., is found in India, Ceylon, and North Queensland. In Ceylon it yields a gum called Madatia, but we know nothing of its properties or composition. *Albizzia porcera*, Benth., yields a partially soluble gum; and other *Albizzias* and *Pithecolobiums* will probably be found to yield similar gums.

A small quantity of the gum of *Castanospermum australe*, A. Cunn., in my possession seems to resemble the *Sterculia* gums, but I have not yet examined it. I have also a small quantity of the gum of *Derris scandens*, Benth. I have not yet seen the gums of our *Erythrinas;* an Indian-grown specimen of *E. indica*, Lam., is stated to be a "brown gum of no value." A very large plant (stem about an inch in diameter) of *Kennedya rubicunda*, Vent., has yielded a little gum. I have described a kino from *Milletia (Wistaria) megasperma*, F. v. M., and a gum from *Mezoneuron Scortechinii*, F. v. M.,* and have since acquired a little gum from *M. brachycarpum*. Red Cedar gum (*Cedrela australis*, F. v. M.) and gum of *Flindersia maculosa*, F. v. M.,† have been analysed and possess interest, if only because they are the only gums of our Australian Meliaceæ yet examined. I have received a true gum from *F. australis*, R. Br., and a small quantity of a gum from Bog Onion (*Owenia cepiodora*, F. v. M.), but have not examined them, and would point out to chemists that we know nothing of a true gum from any other Australian genus of Meliaceæ.

The *Macrozamia* (*Encephalartos*) gums appear to be practically the same, no matter the species. I have examined *M. perowskiana*, Miq., and *M. spiralis*,‡ Miq. They mainly consist of metarabin.

Since I found pararabin in *Sterculia* gum,§ I have examined other Sterculiaceous gums (*Tarrietia*, &c.) with similar results. There appears to be a good deal of uniformity in gums of this Natural Order.

Coming to the Malvaceæ, the "nutritious white gum," spoken of by Grey‖ as having been found on the bark of the Gouty Stem-tree (*Adansonia Gregorii*, F. v. M.), would appear to be closely allied to the above. It does not appear to have been examined, neither has the "dark-red gum" spoken of by Bentham (*Fl. Aust.*) as exuding from the fruit. No one has yet examined the "rich yellow gum on the seed-vessels, like gamboge," described by Rev. J. E. Tenison-Woods as occurring on *Thespesia populnea*, Corr., in Northern Queensland.

The Tiliaceæ are closely allied to these two Natural Orders, and it is not surprising to find that the family likeness extends to their

* Proc. Linn. Soc. N.S.W. [2], vi., 679.
† Proc. Linn. Soc. N.S.W. [2], iv., 1047; Proc. A.A.A.S., ii., 379.
‡ Chem. and Drugg. of Australasia, Jan.—Feb., 1890.
§ Pharm. Journ., [3], xx., 381.
‖ Journal of Two Expeditions, &c., p. 112.

gums. The gum of *Echinocarpus australis*, Benth.,* has a good deal in common with the *Sterculia* gums and that of three species of *Elæocarpus* (*grandis, cyaneus, obovatus*), imperfectly examined by me, appear to strongly resemble the group. I notice that Seemann (*Flora vitiense*) quotes Mr. Storck as having found a *gum-resin* on *E. Storckii*, Seem., from Fiji. This exudation should be further examined.

As recent work in the gums, &c., of the dry interior, I may refer here to my examination of the exudations collected by the Elder Expedition.† Professor Tate has also just placed in my hands the exudations collected by the Horn Expedition, which, though few, appear to be very interesting.

The aromatic Natural Order Rutaceæ is hardly one in which to expect true gums. In India and other places gums have been found in *Citrus*, *Feronia*, &c. I have gums from *Pentaceras australis*, Hook. f., and *Xanthoxylon brachyacanthum*, F. v. M., but have not been able to examine them yet. Turning to the Sapindaceæ, I have gums from two species of *Cupania* and one of *Nephelium*. That from *Nuytsia floribunda*, R. Br., a Loranth from Western Australia, is stated to be "a tragacanth-like gum which swells in water, but does not dissolve."‡ It requires examination.

The gums of *Panax*§ closely resemble those of *Acacia* ; it would be interesting to examine others of the Araliaceæ. The *Terminalia* gum, used for food both by Leichhardt and Stuart in North-western Queensland and the Northern Territory, is described as being very similar in appearance to gum tragacanth, but we know nothing more about it, and authentic specimens should be gathered and analysed. This brief sketch of our gums shows how little has been done in the subject, and how much there remains to be done.

RESINS.

Our resins comprise some most interesting substances. In my opinion they are *the* most interesting of the exudations, and I sometimes wonder why they have not more frequently engaged the attention of investigators. The difficulty of obtaining authentic material is not present in all cases. For instance, an up-to-date examination of the resins so well known as Grass-tree Gum is badly wanted, particularly as the substance promises to again have some commercial importance. I have recently given an account of these "gums"‖ which may save the chemist some trouble.

Some of our Coniferous resins are of more than ordinary interest, and those of *Frenela* (*Callitris*) are destined to be of commercial importance. They are in every respect identical with the sandarach of commerce (the product of *Callitris quadrivalvis*, Vent.).

Our *Araucarias* yield very interesting exudations which are true gum-resins — an unexpected occurrence in the Coniferæ. MM. Heckel and Schlagdenhauffen¶ made the first announcement of the occurrence of a gum in an *Araucaria* exudation. Unaware of this research, I announced a similar discovery to the Royal Society of

* Proc. Linn. Soc. N.S.W. [2], vi., 140. † Proc. R.S. S.A., xvi., 1.
‡ Col. and Ind. Exh. Reports, 1886. § Proc. Linn. Soc. N.S.W. [2], vii., 35.
‖ Agric. Gaz. N.S.W., v., 748.
¶ Comptes rendus, cv., 359 (16th August, 1887).

Queensland,* finding arabin in *A. Cunninghamii*. Heckel subsequently† gave analyses showing arabin to occur in three additional *Araucaria* exudations (making four in which he found it). He later on found arabin in the Chilian *A. imbricata*, Pavon; and it was reading an account, in a Chilian scientific journal,‡ of this research that first made me aware of Professor Heckel's work on *Araucaria* gum-resins. His courteous reply to my request for information has enabled me to present my hearers with this account of what has been done in regard to the investigation of these very interesting substances.

Dr. T. E. de Vrij collected in Java from *Podocarpus cupressina* a resin which, on treatment with alcohol, yields a white crystalline acid substance. Oudemans§ has worked at this acid, and describes some of its salts and derivatives. We have four species of *Podocarpus* (*Nageia*), and one at least (*P. elata*, R. Br.) might be expected to yield resin. The others are shrubs; and if they yield it at all, it would only be in very small quantity. I have never heard of a resin having been found on an Australian *Podocarpus*, but would suggest that it be carefully looked for, and examined for podocarpic acid and other bodies.

Through the courtesy of Mr. F. M. Bailey I was enabled to examine an oleo-resin from a new Queensland species of *Canarium* (*C. Muelleri*, Bail.). The substance is the more interesting for the reason that Manilla elemi is supposed by some to be the product of *C. commune*, Linn., but the Queensland exudation proves to be simply a solution of a resin in a volatile oil, and to be free from amyrin.

No doubt a number of interesting resins and gum-resins will be found in the Rutaceæ. I have gum-resins (?) from *Evodia accedens*, Blume, and *Medicosma Cunninghamii*, Hook. f., which must wait their turn for examination.

My research on the *Pittosporum* exudations‖ will be amplified as soon as I get additional material. The exudations of other species require to be carefully examined, and the true gum stated to be found on *P. phillyræoides*, DC., should not be omitted.

"From wounds in the bark of *Ailanthus imberbifolia*, F. v. M. (Simarubeæ), a resinous substance exudes, which burns with a brilliant flame"—(Thozet).¶ I am not aware that this substance has ever been examined; it would probably prove interesting.

A sticky aromatic resin exudes from Red Cedar (*Cedrela australis*, F. v. M.) when enclosed, on keeping. We know nothing of its composition; neither do we know anything about the resinous exudations found on the foliage of *Owenias*, *Flindersias*, &c., which are sometimes of an alliaceous odour. Has anyone examined the exudation which is similarly found on *Dodonæa viscosa*, Linn. (Sapindaceæ)?

* Proc. R.S. Qd., vi. (16th August, 1889).

† Revue des Sciences naturelles appliquees, No. 16, p. 14 (20th August, 1891).

‡ "Proces-Verbaux" of the Actes de la Societe Scientifique du Chili, tome ii., lere Livraison (1892). [Sesion jeneral del 4de Abril, de 1892.]

§ Journ. f. prakt. Chimie, quoted in Journ. Soc. Arts, xxii., 864; Watts' Dict., viii. [2], 1657.

‖ Proc. A.A.A.S., iv.

¶ Rep. Intercol. Exh. Melb., 1866-7, 232.

Gum-resin from *Tabernæmontana macrophylla* was shown by New Caledonia at the Paris Exhibition of 1867. Has a similar substance been found on our *Tabernæmontana*, and, if so, has it been examined?

Some time ago twigs (with neither flowers nor fruits) were sent to me from Tasmania under the name of "Leather-tree." The twigs exuded a small quantity of resin, which was stated to possess "great healing qualities in cases of sore hands." Can anyone say what it is, whether it has been examined, or supply material for botanical identification?

A Euphorbiaceous plant (*Beyeria viscosa*, Miq.) exudes resin so freely from the leaves that characters may often be traced on it with a style. A close ally, *Bertya Cunninghamii*, Planch., exudes a bitter gum-resin (?) similarly. Both substances are of much interest, and have apparently never been examined. In Queensland the Candle-nut-tree (*Aleurites moluccana*, Willd.) grows; and confused accounts are current in regard to the exudation it yields, which should be cleared up.

Some correspondence recently published* states the present position in regard to the *Ficus* juices of Australia, which have been a good deal talked about at one time or another as yielders of Caoutchouc (India-rubber). Two grand problems (which, owing to the liability of the raw material to ferment, are far easier dealt with in Australia than at a distance) remain to be solved in connection with them. They can only be adequately solved by chemists. (1.) The chemical composition of the juice (latex) of the various species. (2.) The best method of treating the fresh juice so as to separate the caoutchouc contained in it. The well-known research of De la Rue and Müller† is a little out of date, and a fresh investigation has been commenced by Rennie and Goyder.‡ We look forward with interest to their further investigations.

KINOS.

The astringent exudations of our Eucalypts and *Angophoras* are both abundant and interesting. Kinos of all sorts are somewhat out of fashion in medicine, but it may be that an improved demand will set in for them for tanning purposes. Drs. Lauterer and Wilton Love are working at them, and will no doubt bring to light new points of interest concerning them.

I am very much interested in our kinos, having worked at them for some years. I have divided them into three provisional groups§—(*a*) the *Ruby* group, consisting of kinos of a ruby colour, which are perfectly soluble in water or alcohol; (*b*) the *Gummy* group, which are soluble in water, but largely insoluble in alcohol, owing to the gum they contain; (*c*) the *Turbid* group, which form a turbid solution in water, owing to the catechin they contain. An overwhelming majority of kinos fall into these three groups, those of *Eucalyptus microcorys*, F. v. M. (Tallow-wood), and *E. maculata*, Hook. f. (Spotted Gum), being anomalous. Country pharmaceutical chemists can readily undertake the work of collecting

* Agric. Gaz. N.S.W. v., 759.
† Phil. Trans., 1860; Journ. Chem. Soc., 1862, 62; Watts' Dict., ii., 646.
‡ Journ. Chem. Soc., lxi., 916.
§ Proc. Linn. Soc. N.S.W. [2], iv., 695, 1277; vi., 389.

authentic kinos from the trees in their neighbourhood, place them in their group, and determine their composition. They could then with facility meet any demand that might spring up for them, or create a demand. Kinos of the Gummy group, of course, are unsuitable for tinctures, and in laying in a stock of them the kinos of each group should be kept separate and away from the light. The only Australian kino for which there is a steady demand at the present time is that of the Murray Red Gum (*E. rostrata*, Schl.) Fishermen and others chop a few chips from the trees, and extract the liquid kino. It is caught in jars, dries, and is sold principally in Melbourne.

Besides those of *Eucalyptus* we have kinos of *Angophora*,* both solid and liquid. In addition to these we have a number of astringent exudations from *Casuarina*, *Baloghia*, *Ceratopetalum*, *Rhizophora*, *Milletia*, &c., which are of scientific interest.

EUCALYPTUS OIL

The scientific investigation of individual Eucalyptus Oils is in a very incomplete state, and from the special circumstances connected with them Australian chemists possess peculiar advantages for their examination. They afford a peculiarly tempting subject for research.

The Oleum Eucalypti of the British Pharmacopœia of 1885 is defined as "the oil distilled from the fresh leaves of *Eucalyptus globulus*, Labill., *Eucalyptus amygdalina*, Labill., and probably other species of *Eucalyptus*.

"*Characters and Tests.*—Colourless or pale straw-coloured, becoming darker and thicker by exposure. It has an aromatic odour, and a spicy and pungent flavour, leaving a sensation of coldness in the mouth. It is neutral to litmus paper. Specific gravity about 0·900. Soluble in about an equal weight of alcohol."

The unsatisfactoriness of this definition is recognised by the British Pharmaceutical Conference, for in Question 14 (1894 meeting) it is stated, "Ol. Eucalypti, B.P., a more precise definition of this oil is required." I very much regret that the researches on the numerous substances known as Eucalyptus Oil are not sufficiently complete to be available to the committee appointed to prepare the new Pharmacopœia. Whatever the decision arrived at as regards standards for this oil it must necessarily be based on imperfect information.

Without taking note of well-marked varieties, there are in Australia about 150 different kinds of Eucalypts. A large number of these yield oil, or are capable of yielding it commercially; even yet, with all the work that has been lavished on them, we have no accurate knowledge of 10 per cent. of these oils. We have accurate (and more or less complete) knowledge of those of *E. globulus*, Labill., *E. amygdalina*, Labill., *E. cneorifolia*, *E. maculata*, var. *citriodora*, and meagre knowledge of a few others. Why? Mainly because of the difficulty of obtaining authentic material for research, except from stills situate in the midst of a forest of *Eucalyptus* of one species and no other. I am perfectly certain from my own tests, and from my botanical knowledge of the districts from which oils labelled in a particular way were obtained, that the oils of many workers are often mixed oils. In

* Proc. R.S. Vict., 1889, 82; Proc. Linn. Soc. N.S.W [2], v.

adding to my collection of oils for research, I have endeavoured to call in the aid of distillers in different parts of the country, with the view to have the stills charged with one kind of leaves and no other, but the owners are often very suspicious, and their oils are not to be relied upon for research work. Amongst what I may call educated distillers, very few are willing to submit their oils to the research analyst.

I have bought a large number of oils in open market, and have acquired other oils under special circumstances, but as regards the oils of many species, I find my only course is to distil them myself. The still is under construction in the Technical College, and I have made arrangements to send my own collector to collect leaves botanically true. I thus begin the bed-rock, just as I have with gums, tans, and timbers. My only regret is that, from the nature of things, the research must be protracted. Meantime I have a good deal of material to work upon, more, in fact, than I can get through for a considerable period with the present demands on my time. In this connection I would point out that if country pharmaceutical chemists have neither the time nor the inclination for research work on eucalyptus oils, they could do yeoman service in the matter by supervising the distillation of eucalyptus oils true to name for research purposes.

Eucalyptus globulus, Labill.—This is a Tasmanian and Victorian tree, which is practically unknown in the other colonies to the average citizen. It has been largely planted in other countries, and so often written about that many people, even in these colonies, think that there is but one *Eucalyptus*, and its name is *globulus*. In other words, that *Eucalyptus* and *globulus* are convertible terms. This accounts for the great preponderance of the literature of *E. globulus*. At the same time *E. globulus* is an oil which may readily be obtained in a state of purity, so that the researches of Schimmel, Wilkinson, and other modern workers referring to it may be relied upon.

This oil is largely in favour in Europe. The *Eucalyptus* plantations of Algeria now yield a considerable quantity of oil, and there is a tendency to supplant the oil produced by the native country of the species. I observe that Schimmel and Co. guarantee 60 per cent. of cineol in their oil and absence of phellandrene, "which latter constituent is present in Australian oil."*

Schimmel gives the percentage of yield of oil from raw materials from 1·6 to 3 per cent. In Gippsland the usual percentage is perhaps 1·25 to 1·5. The same firm† also gives the sp. gr. at 15° C. at from ·91 to ·93. A complete analysis shows the presence of valeraldehyde, butyraldehyde, capronaldehyde, and pinene, in addition to cineol. Optical rotation +1° to +20°. Wilkinson gives the sp. gr. from ·89 to ·95. Usually it is well over ·9, readily satisfying the requirements of the B.P. in this respect.

Eucalyptus amygdalina, Labill.—This tree, which principally goes under the name of Peppermint of one sort or another, is found in Tasmania, Victoria, South Australia, and New South Wales, being more widely distributed in the last colony than it was supposed to be. It is not only very abundant, but it grows to a very large size, and its

* Bericht, Oct., 1893. † Bericht, Oct., 1893, p. 19.

oil-yield is comparatively great (2 to 3 per cent). We know very little yet of the variation in the oils of *Eucalyptus* caused by different circumstances of habitat, size, and season of growth of the trees. My experiments with *amygdalina* tend to show that its specific gravity is low—say, from ·862 to ·885 in ordinary samples; it contains but little cineol, and an overwhelming proportion of phellandrene. I observe, however, that Wilkinson* gives the specific gravity of oil of this species (taking only two decimals) at ·85 to ·89, and from ·91 to ·96 (? a blended oil).

E. amygdalina is very largely sold in Australia under the generic term of "Eucalyptus Oil," but it is also a great deal used for blending, so that I doubt whether much arrives in England in the pure state. In fact blending is a good deal more resorted to than is usually imagined.

Schimmel and Co. state that the oil of *Eucalyptus crebra* and *E. hemiphloia* are "very rich in cineol."† The former is the Narrow-leaved Ironbark and the latter is Grey Box. Both trees are very abundant, and should be tested for oil yield. The same firm also state that the oil of *E. microcorys*, F. v. M. (Tallow-wood), contains cineol, has a sp. gr. of ·935, and boils between 160° and 200°.‡ Staiger states that the leaves yield about 2 per cent. of oil, and I certainly think that this is a species which should be carefully tried by the distiller. *E. odorata*, Behr. (sp. gr. ·907), containing cuminol in addition to cineol, should also be tried. Schimmel also states that *E. populifolia*, Hook, contains "a fair proportion of cineol." I have recently examined the oil of *E. pulverulenta* (Argyle Apple), which has not been previously described. It is of a bright green colour, like Cajeput, has a specific gravity of ·9145 at 23° C., gives excellent results for cineol, and shows only the slightest indications of phellandrene. When re-distilled, aldehydes commence to come over at 110° C., and between this and 171° C., when the temperature becomes stationary, 10 per cent. has distilled over. An additional 85 per cent. comes over between 171° and 195°. This distillate is a very good oil, only showing a slight tinge of green, is rich in cineol, and almost free from phellandrene. It has a sp. gr. of ·912 at 25° C. This oil is very full of promise, and I intend to further examine it.

Schimmel has examined the oil of *E. rostrata*, Schlecht.‡ (Murray Red Gum). Its sp. gr. at 15° C. is ·924, and optical rotation +12° 58′. Besides Cineol it contains Valeraldehyde. This species is worthy of proper practical tests. The same firm, however, find no cineol in a Queensland sample of *E. tereticornis* oil. If this be confirmed it will be remarkable, considering the close botanical affinity of this and the preceding species.

For practical purposes it is convenient to deal with the mallee oils separately. The vegetation of Kangaroo Island, South Australia, is mainly composed of a mallee, the Narrow-leaf Peppermint (*E. cneorifolia*), and it yields an oil of high specific gravity and Cineol percentage, and contains little or no aldehydes. The oil of *E. dumosa* is also valuable. That of *E. oleosa* has been examined by Schimmel,‡

* Proc. R.S. Vict., 2, vi., 197. † Bericht, April, 1893, 38.
‡ Bericht, Oct., 1893, p. 21.

who pronounces it to contain both cineol and cuminol. Its sp. gr. at 15° C. is ·915—·925, and optical rotation −3° and −5°, Wilkinson.

The term "oleosa" has, however, been sometimes used in a generic sense, and hence we cannot always guarantee that the oils labelled "oleosa" are the sole product of *E. oleosa*, F. v. M. There are other species of mallee, but as some confusion has arisen in regard to their various products, a monograph of mallee oils would be invaluable.

Under the head of "Scented or Perfume Oils," that of *E. maculata*, Hook., var. *citriodora*, stands pre-eminent. It has contained as much as 95 per cent. of citronellon and 5 per cent. of geraniol. It is soluble in from 4 to 5 parts of 70 per cent. alcohol. One sample was optically inactive, another slightly dextrogyre. Boils between 209° and 220°, sp. gr. ·87 to ·905,* but ·87 to ·88 (Wilkinson).

The oil of the "Lemon-scented Ironbark (*E. Staigeriana*, F. v. M.), is even more sweetly scented. It is high in oil yield. Its sp. gr. at 15° C. is ·88, and it boils between 223° and 233°. It contains citral.* Owing to their volatile nature these oils have not been that commercial success it was hoped they would have been.

Cineol (Eucalyptol).—Is represented by the formula $C_{10}H_{16}O$. Its specific gravity is ·930, and boiling point 176-177° C. It is a colourless and transparent liquid, is optically inactive, and belongs to the Camphor group. It crystallises at a low temperature (−1° C), and this property enables it to be separated (by repeated crystallisations) in a pure state from mixtures containing it. In our warm climate the separation of crystallisable cineol is attended with difficulty, particularly if it contain terpenes, for those bodies are solvent in cineol. In fact, the presence of cineol in an oil rich in terpenes is very difficult to detect, and hence oils have often been returned as containing no cineol, when, as a matter of fact, they do contain it. There are certain chemical tests for the detection of cineol, but they are by no means easy of application.

It has been assumed, and it has been endeavoured to prove, that cineol is the only therapeutically active constituent of eucalyptus oils. It is the practice of some to determine the value of eucalyptus oils simply according to the percentage of cineol. But we must suspend our judgment in regard to cineol being the only valuable constituent of eucalyptus oil. I am personally aware of beneficial effects which have attended the use (for inhalations, &c.), of oils which I have shown to practically consist of phellandrene. Endeavours are made to completely replace eucalyptus oil in therapeutics by the pure body (cineol). I do not dispute the therapeutic value of cineol, and while I am fully aware of the advantage in therapeutics of dealing with a substance of defined chemical composition, it will be found impossible in practice to supplant the innumerable eucalyptus oils of all degrees of cineol content, and some of which are nearly or entirely destitute of it.

Cineol has been included in the Pharmacopœia of the United States. Tests imposed, in addition to those indicated above, are that equal parts of cineol and soda-solution, shaken together, must not

* Bericht, October, 1893.

change in proportion of volume. Also, the alcoholic solution must not alter the colour of litmus paper, nor assume a brown or violet colour by the addition of a drop of solution of ferric chloride, showing absence of phenols.

PHELLANDRENE—This is one of several true terpenes represented by the formula $C_{10}H_{16}$. It is capable of existing in two optical modifications, one turning the plane of polarised light to the left and the other to the right. It boils at about 170°.

With many writers on eucalyptus oils it is a veritable pariah amongst terpenes, its presence disqualifying a eucalyptus oil. Those who object to its presence look upon it as a mere diluent of eucalyptus oil, stating that it possesses no medicinal properties that are not possessed by the terpenes of the cheaper oil of turpentine. At the same time we have no direct evidence that the terpene phellandrene is not a therapeutically active constituent of eucalyptus oil. In some it is entirely absent, in most it exists in greater or less quantity. It may be readily detected in an oil if treated with a concentrated solution of sodium nitrite. If a few drops of glacial acetic acid be added to the mixture, a copious formation of crystals of phellandrene nitrite (of a whitish colour) ensues.

ALDEHYDES.—The pungent and irritating odour of the oils of some species is owing to the presence of aldehydes, and fortunately there is no real difficulty in removing them by rectification. These cough-producing substances should always be removed, and I have heard a curious reason why manufacturers retain them in some oils. It is that the public like a pronounced flavour—some "fire" in the oil, in fact; but I hope that the taste of the public will become enlightened, for these aldehydes may cause most serious results in persons suffering from throat, bronchial, or lung troubles, while I know of no compensating value whatever.

At the same time there are some sweet-scented and non-injurious aldehydes—*e.g.*, citronellon, which forms so large a proportion of the oil of *E. maculata*, var. *citriodora*.

Various eucalyptus oils contain other constituents, but they are of minor importance.

OTHER ESSENTIAL OILS.

Most of the work on Australian essential oils other than *Eucalyptus*, has been done on *Melaleuca*. The oils of *M. decussata*, R. Br., *M. ericifolia*, Sm.; *M. uncinata*, R. Br.; and *M. Wilsoni*, F. v. M., have been examined by Wittstein and Mueller.* *M. ericifolia*, Sm., and *M. linariifolia*, Sm., have been examined polarimetrically by Dr. Gladstone†, while other oils have been examined less thoroughly. In view, however, of recent researches into the constitution and properties of essential oils, it is very desirable that the *Melaleuca* oils should be examined *de novo*. The plants are amongst the commonest of the Australian vegetation, so there need be no real difficulty in getting supplies of various oils true to name. Schimmel and Co.‡ have published brief notes in regard to three of them, but beyond

* "Wittstein's Organic Constituents of Plants," (Mueller's trans., p. 152).
† Journ. Chem. Soc., xvii., 3. ‡ Bericht, April, 1892, p. 60.

these nothing has been done. They describe the oil of *M. acuminata* F. v. M., from South Australia, as colourless, and as having an odour slightly resembling juniper berries, sp. gr. 0·892, optical rotation —15° 20′. It contains a considerable quantity of cineol. The oil of *M. uncinata*, R. Br., also from South Australia, has a sp. gr. of 0·925, and an optical rotation of +1° 40′. The principal part dissolves between 175° and 180° C. The lowest boiling fraction possesses a decided Spike or Rosemary odour. The second fraction has a smell of pure cineol, which is the most important constituent of the oil. The highest boiling portion probably consist of terpinol.

Schimmel and Co. have also examined some oil of *M. leucadendron*, Linn., var. *lancifolia*, from Queensland. Like common cajeput oil (to which, botanically, it is very closely related), it consists mainly of cineol, has a sp. gr. of 0·955, and an optical rotation of —3° 38′.

The oil of *M. viridiflora*, a plant which forms a considerable part of the scrubby vegetation of New Caledonia, where it is known as niaouli, has also been carefully investigated by G. Bertrand,* and his researches will be of assistance to workers on our *Melaleuca* oils.

Oils have also been prepared from our indigenous *Menthas* and *Prostantheras*, also from *Zieria Smithii*, but only superficially examined. *Atherosperma* has been alluded to under "Drugs," while certain sweet-scented oils will be referred to briefly under perfumes. I could indicate a number of other plants awaiting investigation as regards their essential oils, but *cui bono* so long as the commonest species remain practically untouched.

FIXED OILS.

Very little has been done at any time, and probably nothing at all quite recently, in the matter of the fixed oils contained in our native plants. The research chemist has therefore in this direction what is practically unworked ground. Some of our Sapotaceous seeds will doubtless prove to be good oil yielders—*e.g.*, Black Apple (*Achras austra is*, R. Br.), the seeds of which are very similar to those of *Bassia latifolia*, Roxb., which yield Mahwah oil in India. The seeds of *Ricinocarpus pinifolius*, Desf. (Euphorbiaceæ), Quandong kernels (*Fusanus acuminalis*, R. Br) (Santalaceæ), might be examined, to begin with, the principal difficulty being the collection of the seeds. But the acquisition of raw material is never an insuperable difficulty to the chemist in earnest in the matter.

PERFUMES.

It may not be strictly scientific to divide Perfumes from Essential Oils, but it is convenient in practice—at least from an economic point of view. We have very many sweet-scented flowers, and they might be jotted down as observed, in order that experimenters may subject them to distillation, or adopt other means to arrive at the properties or composition of the odours. In many cases the amount of oil or other fragrant body that comes over is very minute, rendering, on this ground alone, the work of the experimenter very difficult.

* Compt. Rend., cxvi., 1070; Bull. Soc. Chem. [3] ix., 432; Journ. Chem. Soc. lxiv., 523, 727; Pharm. Journ. [3] xxiii., 989.

Some of our *Andropogons*, particularly in Queensland, the Northern Territory, and Western Australia, contain a sweet-scented oil allied to the Lemon-grass oil of India. *Chrysopogon parviflorus*, Benth., might be examined for a similar oil. A sweet-scented oil has been obtained from *Pittosporum undulatum*, Vent., but only a few general experiments have been performed with it. A thorough chemical examination is a desideratum.

The list of Wattles (*Acacia*) which possess distinctly odorous flowers is a very long one. It includes most of the varieties of *A. decurrens*, Willd. (other than *normalis*), *pycnantha*, Benth., *conferta*, A. Cunn., *suaveolens*, Willd., *pubescens*, R. Br., *implexa*, Benth., *dealbata*, Link. Perhaps these plants more directly concern the pharmaceutical chemist, but we are ignorant of the substance to which they owe their perfume. Neither do we know the nature of the substance to which the various myall woods and their congeners owe their sweet odour. They are *A. pendula*, A. Cunn., *A. harpophylla*, F. v. M., *A. glaucescens*, Willd., *A. doratoxylon*, A. Cunn , *A. acuminata*, Benth., and perhaps others.

Other plants with sweet perfumes are *Cynoglossum suaveolens*, R. Br., various *Stackhousias*, *Symphyonema paludosum*, R. Br. (whose odour reminds one of patchouli), *Boronia megastigma*, Nees., *Murraya exotica*, Linn. *Zieria obcordata* and *aspalathoides* might be distilled, and the oils examined.

A number of our *Olearias* (Asters), perhaps more than usually supposed, possess a delicate musky odour. Of these *O. argophylla*, F. v. M., is perhaps the best known. It appears, after careful experiments, that the perfume cannot be obtained by distillation as an essential oil. I have not heard, however, whether any attempt has been made to collect the perfume by "enfleurage." Other sweet-scented composite plants are *Pterigeron liatroides*, Benth., and *Humea elegans*, Sm. The perfume of the latter is very powerful, and is, at least in part, owing to the presence of coumarin.

The following plants, amongst others, contain coumarin, but we are ignorant as to the percentages :—*Alyxia buxifolia*, R. Br., *Ceratopetalum apetalum*, Don., *Humea elegans*, *Hierochloa*. A fern, *Polypodium scandens*, Forst., develops a powerful odour of coumarin in drying.

As regards perfumes of the bad sort, we know nothing of the substance to which *Hydrocotyle laxiflora*, DC., and various *Opercularias* owe their abominable smell. The flowers of *Tecoma australis*, R. Br., also sometimes have a putrid smell, and hence attract blowflies. Other plants can be called to mind with nasty odours, but I have diffidence in asking experimenters to take them up, as I might be asked to set an example.

But by far the most important commercial indigenous perfume is the Sandalwood of Western Australia, the product of *Fusanus spicatus*, R. Br. (*Santalum cygnorum*, Miq.)

A second Sandalwood which has received attention is that of *Fusanus* (*Santalum*) *acuminatus*, R. Br. (*Santalum Preissianum*, Miq.), the well-known Quandong. I am aware that the Sandalwood oil of commerce (East Indian) finds a place in the B.P. as a drug, but the chief use of Sandalwood is as a perfume, which is a convenient classification in the present instance.

For practically the whole of the exact knowledge of the composition of our Sandalwood oils, we are indebted to the enterprise of the celebrated essential oil firm of Schimmel and Co., of Leipzig, Germany, and my notes are mainly taken from their *Berichte.* Western Australian Sandalwood has been exploited for very many years, having been probably discovered by Malays at a very early period. It is chiefly exported to Singapore and China for burning in temples, and to give some idea of the magnitude of the trade, 4,470 tons, valued at £33,525, were exported thence in 1889, and this was by no means the highest yearly export. But it was not until 1890 that Sandalwood oil in bulk was placed upon the London market. It had, however, for at least five years previously been tested by medical men in the colonies,* and particulars are given in regard to its specific gravity, solubility in spirit, &c.† The makers in Western Australia give the specific gravity of the oil from young and full-grown wood as varying between 0·965 and 0·969, but Schimmel and Co. give it at 0·953, and its optical rotation at —5° 20′ as compared with East Indian at 0·957, and rotation —17° 20′. The above oil is from *Fusanus spicatus.* Schimmel and Co. variously describe the oil as "resinous," and as having "a disagreeable acrid odour resembling turpentine." At present I do not speak from personal knowledge of this oil, as an application I made to the firm in Western Australia for a sample was not even acknowledged, but I am inclined to think that improved methods in distillation and rectification may remove the very unfavourable impression which has been formed in regard to it.

R. A. Cripps, in his "Note on Sandalwood and Cedar Oils,"‡ makes some comparative tests with the Western Australian oil. Schimmel and Co. having imported 75 kilo. of the wood of *Fusanus acuminatus* from South Australia, obtained no less than 3 kilo. 800 grm. of oil from it. "The wood, therefore, contains a good 5 per cent. of oil, and is one of the richest Sandalwoods for oil. In many respects the latter is characteristic and interesting; it is viscid, and of a cherry-red colour. At 15° C. its sp. gr. is 1·022."§ The oil possesses the property of solidifying at moderate temperatures, and separating acicular crystals, so that, in the process of distillation, the cooling must be very carefully effected, otherwise the condensing tubes become blocked.§ This body has been obtained pure by repeating re-crystallisation. It forms colourless crystals which melt at 104° to 105°. The body seems to be of the nature of an alcohol.‖ Subsequently A. Berkenheim¶ investigated this crystalline substance, verifying the surmise of Schimmel and Co. that it is of the nature of an alcohol. Its melting point he, however, gives at 101° to 103°, and its formula as $C_{15}H_{24}O$. For further particulars I must refer my hearers to the original memoir. For an account of a microscopical examination of the wood, with drawings, see Pharm. Journ. [3], xvi., 759.

Baron von Mueller suppresses *Fusanus*, merging this genus in *Santalum.* Probably the whole of the species have wood more or less

* Chemist and Druggist, 28th March and 4th April, 1891.
† Bericht, April, 1891, p. 56. ‡ Pharm. Journ. [3], xxiii., 461.
§ Bericht, April, 1891, 63. ‖ Bericht, October, 1891, 45.
¶ J. Russ. Chem. Soc., xxiv., 688; Journ. Chem. Soc., lxiv., 666; Schimmel's, Bericht, April, 1894, 50.

scented, several of them distinctly so. It would be very desirable to examine the essential oils from every one of them, both as to percentage of raw material and composition. *Fusanus persicarius*, F. v. M., should be first taken in hand, in order to compare with the oils of the other two species of *Fusanus* which have already been examined.

Another so-called Sandalwood is the "Budda" or "Budtha" (*Eremophila Mitchelli*, Benth.). It is very desirable that the wood of this and other fragrant *Eremophila* woods, and that of *Myoporum platycarpum*, R. Br., should be distilled and their oils examined.

DYES OR TINCTORIAL SUBSTANCES.

The coal-tar dyes have ruined vegetable dye industries in most parts of the world, and have rendered it extremely improbable that any of our indigenous dye-stuffs may possess economic value. Nevertheless a number of our plants promise to yield colouring matters of high scientific interest; but, as far as I know, Professor Rennie,* of Adelaide, is the only chemist who has been tempted to make serious investigations in this direction, besides his work of years on the colouring matter of the tubers of *Drosera Whittakeri*. Another substance which promises to yield results of high scientific interest in his hands is the yellow powdery substance found on the winged seeds of *Lomatias*.† The researches of Rosoll‡ on the colouring matter of Yellow Everlastings (*Helichrysum bracteatum*, Willd.); Schunck§ on the chlorophyll of *Eucalyptus globulus*, Lab.; and Flückiger‖ on the ash of the capsule powder of *Mallotus phillipinensis*, Muell. Arg., complete the catalogue as far as I know.

Following are the few researches I would suggest to chemists:—The wood of the Cockspur Thorn or Native Fustic (*Cudrania javanensis*, Trecul.) has been used as a yellow dye for many years, but has not been investigated. Do any of our native species of *Indigofera* (particularly *I. australis*, Willd.) yield indigo? The barks of *Pipturus argenteus*, Wedd., *Cœlospermum reticulatum*, Benth., *Zieria Smithii*, Andr., various species of *Persoonia*, and many other Australian plants yield tinctorial matters worthy at least of preliminary examination. The flowers of *Cedrela Toona*, Roxb., yield an excellent yellow and red dye for silk in India. Will any chemist ascertain whether the flowers of our Red Cedar (by some botanists said to be identical with *C. Toona*, and, at all events, very closely related to it) contain a similar substance?

TANS.

It is probable that the barks of *Acacias* (Wattles) will remain for all time the staple tan material of Australia. In my "Wattles and Wattle-barks" I have embodied the result of a large number of analyses of representative barks, and in spite of the acquisition of many data since its publication, my views as to the comparative value of the barks specified remain unaltered. For the sake of uniformity of results and rapidity of working, I would advise chemists to adopt

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* Journ. Chem. Soc., li., 371; Proc. R.S. S.A., x., 72; this journal, ii., 398; Journ. Chem. Soc., lxiii., 1083.

† This journal, v., 326.

‡ Monatshefte, v., 94; Pharm. Journ. [3], xiv., 967.

§ Chemical News, xxxi., 32.

‖ Archiv. de Pharmacie, 230, i., 2; Pharm. Journ. [3], xxiii., 894.

Schröder's modification of Löwenthal's process of tan-analysis. But I would caution my hearers that the results, although strictly comparable if carefully obtained, do not represent gravimetric percentages of the bark. Other peremptory claims on my time have prevented me determining the constants which, if multiplied by the ordinary results obtained when gallo-tannic acid is used in Löwenthal's process, will give results which are strict gravimetric percentages of the particular group of barks under examination.

The matter of selling wattle-bark by assay is a reform I have long advocated, and I intend to persist in the agitation. Buyers and sellers know perfectly well that with most lots they buy and sell in the dark. One confident buyer often brings the other buyers to bid after him like a flock of sheep. They have a few empirical rules, of which one is that southern bark is far superior to northern. So it is as a general rule, but I have seen this rule pushed to such an ignorant extreme that the same price has been given for a southern bark as for a northern bark of two and a-half times its assay value. Yet if a man tried to sell ores of gold or silver except on assay we should think him a lunatic. The time will come when anyone who attempts to sell at auction bark without assay will be placed in the same category. Chemists should unite as one man to secure the reform, and if they are prepared to make prompt and accurate analyses the reform will come speedily. I suppose, however, that in no branch of colonial commercial analysis have bogus analyses done more harm to the honourable profession of chemists than in regard to tans. To my knowledge some selling and buying brokers have ceased calling in the aid of the chemist because of the discordant results obtained with the same piece of bark. I have been asked scores of times for an accurate method of tannin determination which would enable buyers to run over samples rapidly in the salerooms. I know of no more rapid method than that of Löwenthal, and when those interested in the bark trade are really in earnest there will be no difficulty in exhibiting samples in time for buyers to make the necessary analyses.

There is another matter, of even equal importance, to which I would invite the attention of chemists. What is the sense of conveying, thousands of miles, large and varying percentages of unnecessary cellulose? The foreign tanner wants tannin; he has no use for the ligneous matter. The potentialities of wattle-bark extracts (I lose sight of other barks for the moment) are enormous, and what are the difficulties? Surely, to the practical chemist determined to surmount them, by no means insuperable! The raw material, including the small pieces now wasted, can be digested in wooden vats, the heat of the sun assisting in the evaporation in most parts of the colony. But we have the wood of the trees themselves, and the exhausted "trash" for fuel, while the evaporation can be pushed as far as expedient in vacuum pans, which, owing to the vicissitudes of the sugar industry, can now be obtained at a low rate. The key to the difficulty of getting rid of the superfluous gum in extracts lies, in my opinion, in the judicious use of alcohol, which can be re-condensed and largely saved. Arrangements might be made, if necessary, for constituting each extract works a bond, and using duty-free spirit. The saving of freight by the use of extracts would be very great indeed; the extracts themselves are of fairly uniform composition, while we should be able to bring into use some of our low-grade barks which would not pay to convey to markets in their crude form. Let experiments also be made with alcohol on the bark itself. The gum, ligneous matter, &c., would be left behind, while the tannin and its derivatives would be taken into solution from which an extract can be readily prepared. The thing seems feasible.

I think I have said sufficient to show that the wattle-bark industry presents to the chemist opportunities of scientific research of an important character, and it is no drawback that the achievement of practical results may be attended with substantial pecuniary advantage to the experimenter.

But while Acacia barks furnish our main supply of tanning material, we must not lose sight of other kinds of trees, some of which will be found to yield barks rich in tannin. Research in this direction can be conducted at odd times, but when an analysis is made particulars should be recorded of the date of collection, size of tree, locality, and any other particulars conveniently available for future reference. Patient research of this kind, even if it may appear to bring no immediate pecuniary advantage to the chemist, is in itself a discipline of the highest value to the inquirer into the value (or worthlessness—for negative evidence is useful) of the raw vegetable products of Australia.

TIMBERS.

Scientific investigations of timbers are usually left to the engineer, who subjects them to various stresses, but if the matter be inquired into it will be seen that there is important work for the chemist in connection with these substances. I will briefly make a few suggestions.

Our knowledge of the ashes of our native timbers is quite fragmentary, yet the matter is of much importance to the agriculturist. It would be convenient to many to examine the ashes of particular trees burnt in clearing, and in many cases the kind of tree could be readily noted beforehand. This is precisely the kind of work that many chemists should engage in, otherwise the acquisition of sufficient data will be indefinitely postponed.

The question of the utilisation of our timbers for wood pulp may ultimately be one of great magnitude; but before the subject can have any economic importance, we require to know the percentage of cellulose our timbers contain. This ground is practically untouched.

The substance which is contained in Tallow-wood (*Eucalyptus microcorys*, F. v. M.), and to which the timber owes its greasy or slippery nature, has never been isolated. Black Bean (*Castanospermum australe*, A. Cunn.), is of a greasy nature, so that it will not readily take glue. Other timbers are of this character; what is the reason?

We require special timbers for wine-casks and butter-kegs, and for butter-boxes for the export trade. For both articles the timber must neither absorb nor affect the aroma in any way. The conduct of the necessary preliminary experiments in regard to our native timbers is the work of the chemist.

There is much work for the chemist in the direction of the application of preservatives for timber against fungi (dry rot. &c.), marine borers, and white ants. Then, at the risk of repetition, I would remind you that some of our woods contain bitter principles, essential oils, and colouring matters. It is only the chemist who can make the necessary researches.

FIBRES.

I have very little to say on this subject. The researches of the chemist in regard to our indigenous fibres would seem to be mainly confined to the estimation of cellulose in the various fibre plants and fibres, and to methods for the separation of the fibres from the plant. The work in fibres, which has hitherto been done in Australia, is more of a botanical than a chemical nature. A convenient text-book is that by Cross and Bevan on paper-making (Spon) [Chapters I.-VI.]

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Here is a mighty agenda list! Surely no chemist desirous of taking up original research can complain of the variety of work presented to his choice! If any of the suggestions I have made, or the pleas for research I have put forward, should lead chemists to take up any subject connected with our indigenous vegetation, I shall feel rewarded by the thought that the presidential address to the Chemistry Section has done something to make our organisation true to its name—an Association for the Advancement of Science.

Section C.

GEOLOGY AND MINERALOGY.

ADDRESS BY THE PRESIDENT,

T. W. EDGEWORTH DAVID, B.A., F.G.S.,

Professor of Geology and Physical Geography, University of Sydney, N.S.W.

CONTENTS.

I.—INTRODUCTORY.

A period of nearly thirty-six years has passed over Australian geologists since the time when Mr. (now Sir) Alfred R. C. Selwyn recorded his discovery of a glaciated rock surface in the valley of the Inman River, about seventy miles southerly from Adelaide; nearly eighteen years have glided by since Professor Ralph Tate announced his important discovery of a beautifully glaciated rock pavement at Hallett's Cove, fifteen miles southerly from the same city. The discovery of the former has been neglected or forgotten; that of the latter was at the time received with incredulity. To-day, however, if any geologist were to question the glacial origin of the pavement at Hallett's Cove, he would be looked upon by his fellows as a dangerous lunatic. Thus has the whirligig of time brought in revenges to the old prophets.

The development during the past five years in our knowledge of past ice action in Australia has progressed by leaps and bounds, and important as have been the evidences discovered by those who have studied the marks of Pliocene or Post-Pliocene glaciation in Australia and Tasmania, they are dwarfed when placed beside the gigantic relics of a far more ancient glaciation, the true nature of which has been fully recognised only within the very recent date above mentioned.

Having lately seen some of the principal places in Australia where the Palæozoic ice has been, I propose to tell you briefly what I saw. Before plunging, however, into this part of my subject, I will refer briefly to some of the labours of Australian geologists during the past year, then review the work done by others in the field of Australian glacial geology, and next refer to icebergs, and their direction of drift in the Southern Hemisphere.

II.—NOTES ON RECENT GEOLOGICAL WORK IN AUSTRALIA AND TASMANIA.

The detailed survey of the Charters Towers Gold Field, by Mr. R. L. Jack, the Government Geologist of Queensland, and his able assistants, Messrs. W. H. Rands and A. G. Maitland, is the most highly finished work of the kind ever produced in Australia, and is of great scientific interest, as well as of very considerable practical value.

During the year 1894 the chief work of the geological survey of Queensland has been the mapping of the intake beds of the artesian water basin of Queensland. The chief results of this important work have been summarised as follows*:—

"The basal beds of the Lower Cretaceous formation have been traced continuously from Yeulba Creek to the heads of the Warrego, and have been observed on some of the heads of the Barcoo, their outcrop occupying a belt from five to twenty miles" [*i.e.*, wide—T.W.E.D.]. For a distance, therefore, of over 500 miles from the southern boundary of Queensland northwards, the area of the intake beds is about forty times in excess of the previous rough estimates, a discovery which is most encouraging for all those who are interested in the development of the resources of this vast artesian basin.

Mr. Jack states that he has obtained evidence of a distinct unconformability between the base of the Lower Cretaceous rocks and the top of the Trias-Jura formation, a fact of great scientific as well as geological interest.

At the end of last year the Royal Society of New South Wales awarded to Messrs. R. L. Jack and Robert Etheridge, junr., the Clarke Medal, as a recognition of the value of their services rendered in the cause of Australian geology, especially shown in their lately published elaborate work on the Geology of Queensland.

In South Australia the excavation of the remains of gigantic marsupials and birds of Pliocene or Post-Pliocene age is being carried on vigorously, whenever the season is favourable, under the auspices of Dr. E. C. Stirling. A summary of the results hitherto obtained have already appeared in "Nature."

During the recent expedition, fitted out by the generosity of the Hon. W. A. Horn, to the Macdonnell Ranges, Professor Tate has discovered that Lower Silurian (Ordovician) rocks containing *Ophileta* or *Euomphalus* and *Opisthoma* extend from Central Australia into Queensland, along the tropic of Capricorn.

Until this discovery the oldest known sedimentary rocks in Queensland, the age of which was determinable on palæontological evidence, were of Middle Devonian (Burdekin) age.

A most useful paper, embodying a vast amount of patient research, has been contributed by Mr. Walter Howchin, on the fossil foraminifera of Australia.†

Of special interest is the first list yet published of the Palæozoic foraminifera of Australia. They are all from Permo-Carboniferous horizons in Tasmania and West Australia.

In Victoria, Messrs. T. S. Hall and G. B. Pritchard, following in the footsteps of Professor Tate and Mr. John Dennant, arrive at

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* *Brisbane Courier*, 1st December, 1894.

† Austr Ass. Avt. Sci., vol. v., Adelaide, 1894, pp. 348-373, with plates X. and XI.

conclusions with regard to the sequence of the Tertiary Strata of Victoria, which are at variance with the classification adopted by the Geological Survey.*

Mr. A. W. Howitt records the interesting discovery by himself that the igneous dykes at the 180 mine at Bendigo, Victoria, are composed of the ultra-basic lava, limburgite.†

In New South Wales the discovery by Mr. W. J. Clunies Ross, and also by Mr. E. F. Pittman, the Government Geologist, and myself, of *Lepidodendron* associated with a fauna of Upper Devonian affinities, has been referred to by me elsewhere.‡

Mr. B. Dunstan has discovered in a bed of clay shale belonging to the Hawkesbury series, and therefore of Triassic age, at Curl Curl Lagoon, Manly, near Sydney, several fossil ferns which Mr. R. Etheridge, junr., identifies as *Oleandridium*. This is the first record, as far as I am aware, of the occurrence of this genus in Australia.§

A useful petrological paper on the basalts of Bondi, near Sydney, has been contributed by the Rev. Milne Curran.‖

In Tasmania the discovery by Mr. E. J. Dunn of Pliocene or Post-Pliocene morainic deposits, and of glacial beds, perhaps of Permo-Carboniferous age, near Mount Zeehan, will be referred to later.

The Government Geologist, Mr. A. C. Montgomery, by his vigorous and outspoken reports upon the Mount Huxley mine, has not only won a reputation for himself by the courage and ability he displayed, but has given an excellent practical demonstration as to the usefulness to the State of such an officer on such an occasion.

III.—EVIDENCES OF GLACIAL ACTION IN AUSTRALIA AND TASMANIA.

(I.) Previous Observations.

One of the first, if not the first, to note glacial action in Tasmania was, perhaps, Mr. Charles Gould, the former Government Geologist.

The statement is made, on the authority of Mr. R. M. Johnston,¶ that, as far back as about 1853, Mr. Gould observed evidences of glaciation in Tasmania, and communicated his views to the Hon. Jas. Reid Scott, formerly Chief Secretary of Tasmania. The latter about twenty-one years ago made known the results of Mr. Gould's observations to Mr. Johnston. Unfortunately Mr. Gould did not publish any account of his discoveries.

The first actual record of ice-action in Australia is that made in 1859 by Mr. (now Sir) Alfred R. C. Selwyn.** The passage reads as follows :—" At one point in the bed of the Inman I observed a smooth,

* "The older Tertiaries of Mande, with an indication of the sequence of the Eocene Rocks of Victoria," by T. Sargeant Hall, M.A., and G. B. Pritchard. Proc. Roy. Soc. Vic., 1894, pp. 180-196.

† Special report. "Notes on samples of rock collected in the 180 mine at Bendigo," by A. W. Howitt, F.G.S., Secretary for Mines. By authority : Melbourne, 1893.

‡ Proc. Lin. Soc. N.S. Wales, vol. viii., series 2nd, 1893, p. 583.

§ Journ. Roy. Soc. N.S. Wales, 1893, pp. 378-379; and Rec. Geol. Sur. N.S.W., 1894, vol. iv., pt. ii., pp. 49-51.

‖ Journ. Roy. Soc. N.S. Wales, 1894, vol. xxviii., 1894, pp. 217-231, plates ix.-xii.

¶ "The glacier epoch of Australasia." Presidential Address. Papers and Proc. Roy. Soc., Tasmania, 1893, pp. 21-22.

** "Geological notes of a journey in South Australia from Cape Jervis to Mount Serle," by A. R. C. Selwyn. Parliamentary Paper No. 20. Adelaide, 1859, p. 4.

striated, and grooved rock surface, presenting every indication of glacial action. The bank of the creek showed a section of clay and coarse gravel or drift, composed of fragments of all sizes, irregularly imbedded through the clay. The direction of the grooves and scratches is east and west in parallel lines; and though they follow the course of the stream, I do not think that they could have been produced by the action of water, forcing pebbles and boulders detached from the drift along the bed of the stream. This is the first and only instance of the kind I have met with in Australia, and it at once attracted my attention, strongly reminding me of the similar markings I had so frequently observed in the mountain valleys of North Wales."

In 1860 the Rev. W. B. Clarke recorded evidence of ice-action at the Muniong (somewhere on the boundary between Victoria and New South Wales, on or near the Kosciusko Plateau).* "Probably in earlier times glaciers did form, for I saw more than one unmistakable *bloc perchè*, a mass resting on upturned edges of strata."

The credit of having been the first to place on record evidence of past glacial action in Victoria belongs undoubtedly to a former Agent-General of this colony and its first Government Geologist, Sir Richard Daintree.

Previous to his appointment as Government Geologist for Queensland, Sir Richard (then Mr.) Daintree served for many years as one of the field geologists to the Government of Victoria. One of his latest works before leaving Victoria for Queensland was to construct, in collaboration with Mr. C. S. Wilkinson, the late Government Geologist of New South Wales, a geological map and sections of the Bacchus Marsh District.

As Mr. Daintree's Report is now very scarce, I may be excused for quoting at length from the original, in which he briefly summarises the principal geological features of this now famous district.†

The following is an extract (*op. cit.*, pp. 10-11):—

"What is seen in this road cutting is exposed on a larger scale near Darley, where blocks of granite, with large crystals of red felspar, in some instances a ton weight, are found imbedded in a matrix of soft mud.

"Then, again, we have masses of conglomerate, composed almost of rounded pebbles; but in all cases a large proportion of these are pebbles of porphyries, red granites, jasperoid rocks, and sometimes of true mica-schist.

"The nearest mica-schist of which we have any knowledge is on a branch of the Glenelg River. Porphyries in dykes are in the Lerderberg Ranges; but the peculiar characters of some of the granites are unknown in Victoria. * * *

"Page and other authors have suggested ice-action—probably icebergs; and this would meet the difficulty at once. * * *

"As the lower Mesozoic age of these beds has been assumed by Professor McCoy on the European analogies of the only distinct

* "Researches in the Southern Goldfields of New South Wales." Second edition. Sydney, 1860, p. 225.

† "Geological Survey of Victoria: Report on the Geology of the District of Ballan, including Remarks on the Age and Origin of Gold, &c.," by Richard Daintree, late Field Geologist. By authority: Melbourne, 1866.

fossil yet found in them — *Gangamopteris longifolius;* and as *Glossopteris* (another Mesozoic type in Europe) has been found in New South Wales and Northern Queensland distinctly associated with Palæozoic Carboniferous fossils, it may not be asking too much to suspend judgment in this case a little longer.

"To those who take an interest in working out this matter, I would indicate, as worthy of further attention, those mud pebble-beds, on the Lerderberg River, immediately below where the river leaves the ranges. Here I have found a few *pebbles grooved in the manner I have read of as caused by glacial action*—[the italics are mine—T.W.E.D.]—and here, I believe, fossil organisms will reward the explorer."

These discoveries by Daintree and Wilkinson are recapitulated by Mr. A. R. C. Selwyn.*

[*Op. cit.*, p. 14.]—" Other smaller patches [of Upper Palæozoic rocks—T. W. E. D.] occur throughout the intervening central portion of the colony—at Bacchus Marsh and Ballan, on the eastern part of the Mount Macedon Ranges; on the Coliban, near Kyneton; on the Wild Duck Creek, near Heathcote," &c.

[*Op. cit.*, p. 15.]—" In several of the localities above enumerated thick masses of conglomerate are associated with the sandstone. They occur generally towards the base of the series, and are composed of a very irregular aggregation of rounded pebbles, and occasionally angular or subangular fragments of all sizes of granite, greenstone, or diorite, various porphyries, hard slate, gritty sandstone, grey quartz rock, and quartz. These pebbles or fragments are imbedded either in a soft, sometimes earthy, mass, showing little or no trace of stratification, as at Darley, near Bacchus Marsh; or are interspersed in a thinly stratified sandy shale, as at the point where the road from Sandhurst to Lancefield crosses the Wild Duck Creek. They more commonly occur in hard cemented masses, as on the Mount Macedon 'conglomerate range.' * * * * The character of the conglomerate beds before-mentioned near Darley, and on the Wild Duck, is such as almost to preclude the supposition of their being due to purely aqueous transport and deposition. It is, however, very suggestive of the results likely to be produced by marine glacial transport; and the mixture of coarse and fine, angular, and waterworn material, much of which has clearly been derived from distant sources, would also favour this supposition.

" Grooved or ice-scratched pebbles or rock fragments have, however, not yet been found."†

In 1877 Professor Tate made the important discovery of the glaciated pavement and glacial beds at Hallett's Cove, and on 7th May of that year he announced his discovery in a course of public lectures,‡ and in 1879 he read a paper on the same subject.§

* Intercolonial Exhibition Essays, 1866-67, No. 3: "Notes on the Physical Geography, Geology, and Mineralogy of Victoria." By Alfred R. C. Selwyn and George H. F. Ulrich. By authority: Melbourne, 1866; pp. 14-16.

† The authors at the time were obviously not aware of Mr. Daintree's important discovery, above referred to, of grooved pebbles on the Lerderberg River.—T.W.E.D.

‡ V. Rep. Fifth Meeting Austr. Ass. Avt. Sci., 1893, p. 31.

§ Trans. Roy. Soc. S. Aust., vol. ii., p. lxiv.

On page lxv. (*op. cit.*) is the following statement as to the evidence at Hallett's Cove:—

"(2.) Smooth, grooved, and striated rock surface, and moraine *débris* at Black Point forming the southern boundary of Holdfast Bay.

"That headland presents a steep cliff face of about 50 feet high to the sea, and there stands a few yards from its edge a low mural escarpment of miocene. The intervening space, which is nearly flat, is covered by drift material, chief amongst which are angular stones and blocks of red granite, gneiss, hornblendic slate, and quartzite; the nearest depôt for which is Normanville, 35 miles to the south. Over some few square yards the drift has been removed, disclosing a smooth surface of siliceous slate, striated and grooved in a north and south direction.

"(3.) Passing to the south, across the mouth of Fields River, moraine *débris* and larger masses of transported rocks are seen encumbering the flat tops of the sea cliffs."

Professor Tate also states (*op. cit.*, p. lxv.), Mr. J. D. Woods, in letter 14th May, 1877, supplies the following particulars:—"I think if you investigate the Torrens Gorge you will find evidences quite as strong as those quoted by Mr. Selwyn. On one side of the hill there is a stream of *débris* which my brother (Rev. J. E. T. Woods) considered to have been left by a moraine. In the bed of the river, near the cottage on the right side, there is a lump of rock which some twenty years ago used to be called the elephant rock. * * * The sides are indented with striæ, and there seems to be no doubt that it must have been carried by some force from a long distance."

In 1878, Mr. Gavin Scoular, in a paper on the Geology of Munno Para, stated his opinion* that to the stranding of icebergs on the south coast of Australia in past geological time is due the presence of erratic boulders, "and probably also the volcanic bombs found strewn along our present coast-line and elsewhere throughout the drift."

These are the volcanic bombs described by Stelzner.†

Presumably Mr. Scoular considers that these bombs were floated on icebergs from some active volcanoes in Antarctic lands.

During the same year, 1879, Mr. R. L. Jack, F.G.S., F.R.G.S., announced the discovery by him of large boulders of granite, &c., in the Permo-Carboniferous rocks of the Bowen River Coal Field, in the following words‡:—

"A few beds of conglomerate are met with chiefly in the lower part of the series—[middle marine series, Permo-Carboniferous, of the coalfield—T.W.E.D.]. The included pebbles are generally of granite, slate, schist, quartzite, and other metamorphic rocks, with a few of porphyrite. The pebbles, which are not always well rounded, have a remarkable tendency to arrange themselves in groups in some of the conglomeratic sandstone beds—a disposition which may possibly be

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* Trans. and Proc. Phil Soc. Adelaide, 1878-9, p. 68.

† Ueber Eigenthümliche Obsidian-Bomben aus Australien. Von Herrn Alfred W. Stelzner, in Freiberg, i. S. Zeitschr, d. Deutschen Geolog. Gesellschaft, Jahrg., 1893, pp. 299-319, pl. vi.

‡ Report on the Bowen River Coal Field, by Robert L. Jack, p. 7, paragraph 39. By authority: Brisbane, 1879.

owing to their having been dropped in heaps from the floating roots of trees, but much more likely from floating ground-ice. Large isolated boulders of granite, &c., occur here and there in the midst of strata of fine sandy or muddy material. These could hardly have been brought to their present positions except by glacial action. Portions of trunks of coniferous trees are occasionally found lying horizontally in the strata."

I am informed by Mr. R. L. Jack that some of the largest of these blocks are of the capacity of about two cubic feet, and they are for the most part angular or sub-angular.

In 1879 Mr. C. S. Wilkinson, the late Government Geologist of New South Wales, recorded what he considered to be evidence of glacial action in the Triassic Hawkesbury seriés of New South Wales* :—

"In the Hawkesbury sandstones, which are over 1,000 feet in thickness, there are occasional intercalated beds of clay shale of a lenticular character, having a maximum thickness of perhaps 15 to 20 feet.

"The shales contain small fragments of ferns, especially *Thinnfeldia odontopteroides*." Mr. Wilkinson states (*op. cit.*, p. 106):—

"In the sections exposed in the quarries at Fort Macquarie, Wooloomooloo, Flagstaff Hill, and other places, may be seen angular boulders of the shale of all sizes up to 20 feet in diameter, embedded in the sandstone in a most confused manner, some of them standing on end as regards their stratification, and others inclined at all angles. They contain the same fossil plants that are found in the beds of shale from which they have evidently been derived. These angular boulders occur nearly always immediately above the shale beds, and are mixed with very rounded pebbles of quartz; they are sometimes slightly curved as though they had been bent while in a semi-plastic condition, and the shale beds occasionally terminate abruptly as though broken off. Had the boulders of soft shale been deposited in their present position by running water alone, their form would have been rounded instead of angular. It would appear that the shale beds must have been partly disturbed by some such agency as that of moving ice, the displaced fragments of shale becoming commingled with the sand and rolled pebbles, carried along by the currents. Occasionally in the beds above those which contain the angular boulders occur a few rounded pebbles of shale, showing that the currents had swept along for some distance a few of the angular fragments until they had become rounded. These pebbles are usually oval in shape, and are embedded in such a manner that the longer axis of the pebble is nearly always inclined or dips towards the S.W., thus indicating that the transporting currents had come from that direction, whereas the angular boulders in the beds below are, as before mentioned, confusedly heaped together without regard to size. These boulder accumulations occur in irregular patches apparently throughout the Hawkesbury series. Besides in the places already mentioned they may be well seen in the railway cuttings on the Blue Mountains, especially about Katoomba and Mount Victoria," &c.

* Jour. Roy. Soc. N.S. Wales, vol. xiii., 1879. "Notes on the Occurrence of Remarkable Boulders in the Hawkesbury Rocks," pp. 105-107.

In 1879 Mr. A. W. Howitt's paper* was published "On the Physical Geography and Geology of North Gippsland, Victoria," in which he states (*op. cit.*, p. 35)—"Nowhere in Gippsland have I been able to detect any appearances which I could in any way refer to a glacial period analogous to that of the Northern Hemisphere. I have nowhere met with grooved or scratched rocks, erratic boulders, moraines, or any traces of ice action; and I think that had such existed they would have been met with ere this. Mr. Selwyn has, I believe, already noted this. The only features of the country which I think could in any way suggest glacial conditions are the apparently ancient lake-basins near Omeo. Most of these have now been drained, and their beds deeply cut into by the streams."

Lake Omeo is stated (*op. cit.*, p. 4) to be 2,374 feet above the sea.

The next reference to evidences of ice action in Australasia is that made by Mr. R. M. Johnston,† in which he describes ice-borne erratics, some exceeding a ton in weight, embedded in the Permo-Carboniferous rocks of Maria Island, Tasmania. In 1884 Mr. G. S. Griffiths read a paper on "Evidences of a Glacial Epoch in Victoria during Post-Miocene Times."‡ He states (*op. cit.*, pp. 6-7) that "Mr. Wm. Lee, a practical miner of experience, assures me that he has seen ice striations near Wilson's Promontory."

In 1885 Professor R. von Lendenfeldt§ explored Mount Kosciusko, and recorded the occurrence of rock surfaces polished by glacier action and of "*roches moutonnées*," chiefly in the Wilkinson Valley. No traces of glaciation were observed by him below a level of 5,800 feet.

He did not find any distinct moraines.

The extent of the glaciers he estimated (*op. cit.*, pp. 10-11) as perhaps co-extensive with that of the plateau—viz., about 150 square miles, and he estimated that the Wilkinson Valley was once filled with ice for a depth of 500 feet.

Professor R. von Lendenfeldt next, in a paper read before the Linnean Society of New South Wales,‖ entitled "The Glacial Period of Australia," reviewed the evidences he had collected up to that date, and declined to accept the Hallett's Cove evidence adduced by Professor Tate (*op. cit.*, p. 45). Professor Lendenfeldt, however, had not inspected Hallett's Cove. Had he done so he would at once, no doubt, have frankly admitted the genuineness of the evidences of glaciation. He concludes that the glacial period of Australia was probably of comparatively recent date, and was (*op. cit.*, pp. 52 and 53) "isochrone" with the glacial period of New Zealand, and with the "pluviatile period" in Australia, when the rivers were large, and when there was a dense vegetation in many parts of the country which now are barren, and which was sufficient to feed the gigantic *Diprotodon* and other fossil marsupials.

Dr. Lendenfeldt's paper was reviewed and criticised the same year by Captain Hutton.¶ Captain Hutton contends, as he had

* Q.J.G.S., vol. xxxv., 1879, pp. 1-41. † Proc. Roy. Soc. of Tas., p. 20, 1884.

‡ Trans. Roy. Soc. Vic., vol. xxi., 1885, pp. 1-28.

§ Report by Dr. R. von Lendenfeldt on the results of his recent examination of the central part of the Australian Alps. By authority: Sydney, 1885.

‖ Proc. Linn. Soc. N. S. W., vol. x., part i., pp. 44-53, with plates vii. and viii.

¶ "On the Supposed Glacial Epoch in Australia." Captain F. W. Hutton, F.G.S., Proc. Lin. Soc. N. S. Wales, vol. x., part i., pp. 334-341.

urged in previous papers,* that a period of high eccentricity of the earth's orbit might produce a pluvial or diluvial epoch, but not a glacial, on account of the small quantity of land in the Southern Hemisphere. Evidences of glacial action at Kosciusko, Captain Hutton contends, do not necessarily imply a glacial epoch for Australia. He states (*op. cit.*, p. 341)—" If now I should be asked, ' To what, then, do you attribute the ancient glaciers of the Australian Alps?' I should answer, 'It is more probable that Mount Kosciusko once stood some 3,000 feet higher than at present, when Tasmania was joined to Australia, and Central Australia was perhaps a vast lake, than that the temperature of the surrounding ocean should have been reduced 10 degrees without any apparent cause, which is the only alternative.' "

Captain Hutton quotes (*loc. cit.*, p. 337) the opinion expressed by Dr. Cox at the meeting of the Linnean Society of New South Wales, on 27th May, 1885, that there was possible evidence of a colder sea in New South Wales at some not very remote period, furnished by the occurrence of the recent shell *Siphonalia maxima* (Tryon), from an estuarine deposit near Newcastle. These shells, exhibited by Mr. C. S. Wilkinson, were obtained at depths of from 24 to 60 feet below the surface, in sinking through the estuarine deposits of the Stockton and Bullock Island and Wickham coal-pits, and the Harbour Works near Newcastle.†

Dr. Cox stated (*op. cit.*, p. 245)—" Hitherto this species had only been recorded from Tasmania, but he had recently ascertained that it existed also on the Victorian coast, near Port Phillip Heads." Captain Hutton, commenting on this statement by Dr. Cox, says— " If *S. maxima* is associated with other Tasmanian species, most of which do not live now so far north as Newcastle, then this will be by far the most important evidence of a southern glacial epoch that has ever been advanced. But if, on the contrary, it is associated with New South Wales shells, as appears to be the case, then this new evidence will show that in Tasmania it is a survival of a species once more widely spread, and will prove that Tasmania has *not* undergone a glacial epoch since *S. maxima* lived on its shores. * * * * * Certainly it by no means gives the idea of a cold-loving form."

Speaking of the evidence of glaciation at Hallett's Cove, described by Professor Tate, and referring to the erratics only, Captain Hutton states (*op. cit.*, p. 336)—" The granite composing these erratics has not been described, and I am not aware that any attempt has been made to trace their origin. Dr. von Lendenfeldt suggests the South Pole, but I am afraid it will take a more arduous journey than the ascent of Mount Townsend to verify the existence of granite there.‡ All the land that has been examined at present in that direction is volcanic; and if ice-borne erratics had travelled from the Antarctic continent to South Australia, we should expect to find them also in abundance in Tasmania, New Zealand, and the Antarctic Islands, and that some would be volcanic rocks, which is not the case. We must always distrust an attempt to explain an isolated phenomenon by means of a widespread cause. If these erratics had been derived

* N. Zealand Journ. Science, vol. ii., p. 266, and Q.J.G.S., vol. xli., p. 213.
† Proc. Lin. Soc. N. S. Wales, vol. x., pt. 2, p. 245, 1885.
‡ Granite does occur, however, in the Antarctic regions, v. p. 93 of this paper. —T W.E.D.

from Tasmania or New Zealand, we should expect that most of them would be gneiss, or schist, or sandstone, while granite would be rare. Large granite blocks, brought down by ice, are found in Preservation Inlet, in New Zealand; but this granite is a remarkable one, and a fragment of it could probably be recognised. From Australia itself the erratics could not have come, *if they are ice-borne*, because Australia could not have been sufficiently glaciated to furnish icebergs." Captain Hutton expresses grave doubts as to their being iceborne, but admits that as he has not seen the locality he cannot judge of the evidence.

In 1886 Professor Lendenfeldt published an account* of an exploration of the Victorian Alps, with special reference to Mount Bogong, by himself and Mr. James Stirling.

He states (*op. cit.*, p. 73)—"Since then—[the date of the publication of his report upon Mount Kosciusko—T.W.E.D]—the following three instances have been discovered of glacier traces, situated at a much lower level:—

1. Beautiful striæ have been observed in the Mount Safety Group, near Adelaide, at an elevation of 2,000 feet, far away from any high mountains. These have been photographed, and the photos show the striæ very clearly.
2. An isolated erratic block of great size near Jackandandah, on the northern foot of the Bogong Ranges, at an elevation less than 2,000 feet.
3. An immense accumulation of angular blocks—a moraine—taking up a portion of the valley of Mountain Creek, at an elevation of 2,000 feet. This last has been observed by myself.

These facts show that in these three places the glaciers extended down to a level of 2,000 feet at least. Particularly interesting are the undoubtable glacier traces in the Mount Safety Group. It is evident that glaciers could be formed at such a low level only, when the climate was totally different from what it is now."

The position of the "Mount Safety Group, near Adelaide," is unknown to me, and I have concluded that it must be a misprint for the "Mount Lofty Range." As far as I am aware, however, no striated pavements nor any indubitable traces of glaciation have been discovered as yet within that range at such an altitude as 2,000 feet. Possibly the Hallett's Cove glaciated area has been confounded with Mount Lofty, but at the former locality the traces of glaciation have not been observed for much over 100 feet above sea-level. Mr. James Stirling, in the same report as that which contains the reference above quoted from Dr. Lendenfeldt's exploration of Mount Bogong, page 77, states—"In the Mountain Creek Valley, at the northern base of Mount Bogong, large masses of angular and water-worn masses of rock are strongly suggestive of distributed or scattered moraines * * * At the base of the mountain, near the Kiewa, large masses of compact granitic rock are seen smoothed and rounded, also strongly suggestive of glacier abrasion."

In 1885 Mr. R. D. Oldham, Assoc. R.S.M., visited New South Wales, and was directed by Mr. C. S. Wilkinson to a spot near Branxton,

* The Goldfields of Victoria: Reports of the Mining Registrars for the quarter ending 31st March, 1886. By authority: Melbourne; pp. 71-76. With five plates.

where Mr. Wilkinson had the previous year discovered some large erratics, which he believed to be ice-borne. The horizon in which the erratics occur is that of the Permo-Carboniferous Upper Marine series, overlying the Greta coal-measures, and the beds are with little doubt homotaxial with the Middle Bowen series of Queensland, in which Mr. R. L. Jack had previously noted the occurrence of erratics. (*Op. cit.*)

Mr. R. D. Oldham discovered near Branxton one boulder which he described as being "unmistakably striated and polished by ice."*

Mr. Oldham showed me this "boulder." It was certainly minutely striated, and had a dull polish, but I should have hesitated about referring, without some reservation, the polishing and striation to glacial action, knowing how much has been accomplished in this direction by earth movements in beds constituted, like those at Branxton, of a mudstone matrix, through which fairly large blocks of rock are sporadically distributed.

The larger erratics are chiefly of slate and granite, and some of them certainly weigh over a ton. They are associated in the fine bluish-grey mudstones with several varieties of the *Fenestellidæ* and other delicate marine fossils, the perfect condition of which proves that the skeletons of the above organisms were deposited in tranquil sea water. This quite precludes the possibility of such erratics having been drifted to the position where they are now found by ocean currents. An ocean current strong enough to push along a block of granite weighing one ton would obviously crush to powder the delicate calcareous framework of the *Fenestellæ*, as Mr. Oldham points out.

Mr. R. D. Oldham states (*op. cit.*, p. 41)—"It is unfortunate for our present purpose that none of the subdivisions of the Gondwána series in India can be definitely and directly correlated with any of those of the Carbonaceous series, as exhibited in the Newcastle—[in New South Wales—T.W.E.D.]—section, where their relative position is clear and free from doubt. But in Victoria there are some beds, containing *Gangamopteris*, known as Bacchus Marsh beds, which seem to be the equivalents of the Talchirs. * * * But their Palæontology is not the only connection between the two, for, like the Talchirs, the Bacchus Marsh beds contain abundant evidence of the action of floating ice."

Mr. Oldham correlates the Bacchus Marsh beds with the Upper Marine beds at Branxton, New South Wales, and says—"It is impossible to account for the formation of such beds as these, except by the agency of floating ice in large masses; and as both the Talchirs and the Bacchus Marsh beds show that when they were deposited the climate was much more severe than that now prevalent, we may take this as indicating that during their deposition there was a widespread glacial epoch corresponding to that which is known to have occurred in Post-Tertiary times."

On 4th September, 1885, Mr. C. P. Sprent published the following statement†:—

"The granite boulders of the Mackintosh—[Valley—T.W.E.D]—are of a very large size, some at least five tons in weight, and it is

* Records Geol. Survey of India, vol. xix., pt. 1, p. 44.

† "Recent Explorations on the West Coast of Tasmania." Trans. and Proc. Roy Geogr. Soc. of Austral., Vic. Br., vol. iii-iv., p. 58.

impossible to account for their presence except on the glacial supposition."

In 1886 Mr. James Stirling records glaciated surfaces* at elevations between 4,000 and 6,000 feet, on the quartz porphyries of the Cobboras, and on the metamorphic rocks of Mount Pilot down to 3,000 feet. He also describes (*op. cit.*, p. 487) evidences of glaciation at Mount Bogong, 6,508 feet high; and he and Professor Lendenfeldt refer to huge masses of angular and subangular basalt at an elevation of only 1,000 feet above the sea, towards the Reewa Valley, as undoubted moraines.

In 1886 Mr. R. M. Johnston records evidence of huge ice-borne erratics of Permo-Carboniferous age at One Tree Point, Bruni Island, Tasmania.†

In the year 1887, in a paper read before the Geological Society of London,‡ I recorded—

(1.) The possible evidence of ice-action in Siluro-Devonian rocks, as observed by Mr. C. S. Wilkinson. The beds supposed to be of glacial origin are gold-bearing conglomerates two miles north of the town of Temora, in New South Wales. It is stated (*op. cit.*, p. 195) that "the boulders are much rounded, polished, and in some cases striated. The blocks consist chiefly of quartz imbedded in a clayey base; the largest have a diameter of 4 feet." Mr. Wilkinson showed me one of the smaller blocks from this conglomerate. It had the appearance of being a waterworn pebble, and certainly showed striæ, but I think that it was doubtful whether they were of true glacial origin.

(2.) In the same paper I recorded the occurrence of numerous erratics in Permo-Carboniferous Upper Marine strata at Grass-tree, twenty-eight miles north-westerly from Branxton (*op. cit.*, pp. 192-193). They are described as follows:—

"The deposit here consists of reddish-brown to greenish-brown shales, and is crowded with round and subangular fragments of rock, from pebbles no larger than marbles up to blocks one-third of a ton in weight. * * * Lenticular patches of gravel may be observed in places filling contemporaneously eroded hollows; but stratification, if it exists, is not strongly marked.

"Most of the boulders in the beds are more or less rounded, angular fragments being rare; their shape is very irregular, but generally one end is more pointed than the other, and as a rule their outlines are less convex than those of waterworn pebbles.

"Most of the stones presented the appearance of having been ground, and showed a dull polish, and many exhibit well-marked striæ. * * *

"They are scratched on the top, bottom, and sides. The striæ, although plainly visible, are not deeply cut, and no grooves were observed. Most of the boulders are covered with a thin crust of carbonate of lime, the derivation of which is obvious from the calcareous nature of the shales. * * *

"The largest boulders are granite, clay slate and aplite."

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* Proc. Lin. Soc. N.S.W., Second series, vol. i., 1886, pp. 483-488.

† Proc. Roy. Soc. Tasmania, 1886, pp. 23-24.

‡ "Evidence of glacial action in the Carboniferous and Hawkesbury Series, N.S.W." Q.J.G.S., vol. xliii., pp. 190-196.

(3.) In the same paper I added to the possible evidence of ice-action in the Triassic-Hawkesbury series, previously described by Wilkinson, the prevalence of remarkable contemporaneous contorted bedding in the Hawkesbury Sandstones. This is illustrated in the woodcut on page 194 of my paper above referred to. A short time later I observed at Branxton, near where Mr. Oldham obtained his striated pebble, a block of granite measuring 2 feet 3 inches high, by 1 foot 3 inches wide, by at least 3 feet 3 inches long, and bedded in the rocks in such a way as proved that it could not have been laid down simply by the agency of water. It is poised on its edge, and the bed on which it rests shows distinct evidence of having been deeply indented by the erratic, as shown on the enlarged photograph now exhibited, as though the mass of granite had been dropped from a height on to the bed, probably by the agency of floating ice, at a time when the bed formed part of the sea floor.

The overlying strata show no evidence whatever of having partaken of the bending to which the strata immediately underlying the erratic have been subjected.

In 1887 Mr. R. M. Johnston recorded the evidence of recent local ice-sheets and glaciers in the western highlands of Tasmania, notably along the deeply cut ravines of the Macintosh River.*

The same year Professor Tate published a further account of the glacial evidences at Hallett's Cove.†

In the same publication Mr. R. M Johnston recorded his observations regarding recent glacial phenomena in the western highlands of Tasmania.

In 1887 Mr. G. S. Griffiths read a paper on "Evidences of a glacial epoch from Kerguelen's Land, being comments on the 'Challenger' reports."‡

In this he draws special attention to the fact that the lower valleys of Kerguelen Island are scraped and scratched and smoothed by glaciers even to below sea-level, while some of the outlying islands have been powerfully glaciated. (At present the snow-line on the south side of the island, where the above evidence was obtained, is between 900 feet and 1,000 feet above sea-level.)

He also quotes the statement from the "Challenger" reports that "small granite erratics were noted in the Pacific in lat. S. 38°, far from land."

In 1887 Mr. James Stirling, in his paper§ on the Physiography of the Australian Alps, summarises thus the evidence of ice-action in that region :—

"Erratics in the Mitta Mitta and Kiewa valleys, huge blocks weighing many tons; smoothed surfaces on the Cobberas Mountains and Mount Bogong; moraines at the base of the latter at the Mountain Valley; eroded lake basins, Dry Hill; Hermo-mugee swamp, Omeo Lake basin; morainic lake, Mount Wellington; smoothed and scratched surfaces on Mount Kosciusko."

In the same publication, pp. 297 to 299, Mr. W. H. Rands describes certain boulders met with in the beds and reefs of the

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* Proc. Roy. Soc. Tas., p. 202, 1887.
† Proc. Aust. Ass. Adv. Sci., vol. i., pp. 231-232, Sydney, 1887.
‡ Trans. and Proc. Roy. Soc. Vic., vol. xxiii., 1887, Melbourne.
§ Rep. Austr. Ass. Adv. Sci., vol. i., p. 385, Sydney, 1887.

Gympie Gold Field in Queensland. The boulders range from 6 inches to 1 foot in diameter; are rounded and imbedded in clay shales—[of Carboniferous age—T.W.E.D.].

In the same publication, p. 243, Mr. H. Y. L. Brown suggests the probability of floating ice having played some part in the distribution of fragments of the Upper Cretaceous rocks forming the stony downs of the Mesozoic plains of South Australia.

In his elaborate work on the Geology of Tasmania, published in 1888,* Mr. R. M. Johnston enlarged upon and reviewed the evidences of glaciation in Australia and Tasmania.

He ascribes lack of evidence of a severe glacial period in the Pleistocene rocks of Australia and Tasmania to the absence of such geographical conditions as would bar the intrusion of warm equatorial currents at the last period of maximum eccentricity, combined with winter in aphelion.

In 1890 Dr. Feistmantel's work was published on "The Geological and Palæontological relations of the Coal and Plant-bearing Beds of Palæozoic and Mesozoic Age in Eastern Australia and Tasmania." Basing his arguments partly on the evidence of the fossil plants, partly on that of the glacial beds, Dr. Feistmantel correlates the Bacchus Marsh beds of Victoria and Upper and Lower Marine beds of New South Wales with the Dwyka conglomerates of South Africa and the Talchir boulder beds of India, the *Productus* limestone of the Salt Range in India, which overlies the Talchir boulder beds, proving the late Palæozoic Age of the Talchirs, and suggesting the correlation not only of the Talchirs but of the *Productus* limestone in Afghanistan also with the Permo-Carboniferous system of New South Wales.

He states (*op. cit.*, p. 181)—"The most important phenomenon within these various deposits is the conglomerates or boulder beds, about the origin of which there is now the general opinion that they have been deposited through the action of ice in one form or other, the manner of deposition being such as to force upon one this kind of explanation; and besides this there have been found polished and ice-scratched pebbles and boulders within these beds. This circumstance would, of course, indicate a rather general change of climatic conditions over Australia, portions of Africa, India, &c., towards the close of the Carboniferous epoch. But I do not think it was contemporaneous over that whole region, and it appears to me that it set in first in Eastern Australia (New South Wales), destroying the Carboniferous flora at an early date, while in Southern Africa we find still a Carboniferous or coal measures flora of a higher stage, and only hereafter change of climate appears to have taken place there. When the conditions of ice-action ceased, there appeared in Africa, India, Victoria, New South Wales, &c., a luxuriant flora of a peculiar type, which was, however, foreshadowed by a few forms in the Lower Coal Measures in New South Wales. In this period falls the deposition of the Karoo formation in Africa, the Gondwána system in India, Newcastle beds, &c., in New South Wales, Bacchus Marsh beds in Victoria, and so on."

In 1890 Mr. E. J. Dunn, F.G.S., published a paper on the glacial conglomerates of Victoria.†

* Geology of Tasmania, pp. 254-257 and 296-297.
† Report second meeting Austr. Ass. Avt. Sci., pp. 452-456, Melbourne, 1890.

Mr. Dunn records the wide distribution (*op. cit.*, p. 453) of the conglomerate on either side of the Main Dividing Range, especially at Wild Duck Creek on the north, and Bacchus Marsh on the south.

At Turton's Creek, a few miles N.N.E. of Foster (Gippsland), a conglomerate of well-rolled boulders and pebbles is thought to be of probable glacial origin, and near Nhill it is stated that a boring made for water pierced a conglomerate that strongly resembles what is proved to be of glacial origin. He assigns a thickness of only 100 feet to the Bacchus Marsh conglomerates.

He confidently correlates the Bacchus Marsh and Wild Duck Creek beds with the Dwyka conglomerates of South Africa, the latter of which are there capped by the *Glossopteris*-bearing Ecca beds.

As his account of these conglomerates is the first detailed one, it is worthy of being quoted. He states (*op. cit.*, p. 455)—"Almost every species of rock older than the conglomerate itself is represented—granites in great variety, gneiss, schist, quartz rock, sandstones, lydianite, agate, porphyry, amygdaloid, shales, &c., are met with in great variety; vein quartz and jasper are also present. * * * In size the material of the conglomerate ranges from the finest silt up to great blocks several feet across, and weighing in some cases probably twenty to thirty tons.

"From the well-rounded, almost polished pebble or boulder to the rough angular fragment of rock that has been torn from its parent mass, and not subsequently abraded, all are represented in these conglomerates.

"Generally the colour of the groundmass is dark grey, but there are local variations, such as might be anticipated from the manner in which the conglomerates have been deposited.

"Great numbers of well-rounded, large, hard granite boulders having pink-coloured felspar, are found at Wooragee, but here as elsewhere the most numerous are pebbles of a very fine-grained argillaceous rock that is free of laminations. It is of brownish colour and soft, and on these most commonly are found the groovings, scorings, striations, and fine scratches that stamp the conglomerate as of glacial origin. Not only are the pebbles, &c., scored and scratched, but great numbers are rubbed on one or more sides (faceted). Though rounded, many of the boulders, &c., indicate from their peculiar form that water alone was not the agent." * * * (*Op. cit.*, p. 456.) "No other conclusion can be arrived at than that floating ice has been the agent by which the material has been brought into its present position.

"Much of the material is foreign, and many of the rocks are not known to occur at present in this continent anywhere near Victoria. Probably in some distant land, not necessarily to the southward, glaciers slowly pushed their way into the ocean laden with such material as glaciers usually carry. These became broken off eventually, and floated away to destinations governed by currents and winds, the dirt, stones, &c., being deposited on the floor of the sea, or possibly lakes, in which the icebergs floated. * * * Tasmania may have furnished some of them" [*i.e.*, the erratics—T.W.E.D.].

In 1891 Mr. G. B. Pritchard recorded the occurrence of glaciated rock surfaces at a spot to the north of the township of Curramulka,* on the east side of Yorke Peninsula, South Australia.

* Trans. Roy. Soc. S. Australia, vol. xv., for 1891-92, p. 182.

Mr. Pritchard states (*op. cit.*, p. 182)—"To the north of the township there are evidences which seem to be attributable to none other than glacial action, for the exposed surface of the rock is very flat and smooth, and in many places scratched and scored, the general direction of the striæ being north and south, and occasionally deep and smooth grooves are met with. I did not see any rocks of foreign material in this locality, but numerous angular and subangular fragments of the hard limestone. At the coast, however, about one mile to the north of Port Vincent, there are several large boulders of a coarse granite with large felspar crystals, which may have been carried there by glacial agency; but, as I am informed that granite occurs *in situ* both to the north and south of this locality, the presence of these boulders may have been due to other causes."

In 1892 Mr. E. J. Dunn's special report on the glacial deposits of Wild Duck Creek was published by the Victorian Government.*

This memoir is beautifully illustrated with plates from photographs taken by Mr. A. W. Howitt.

The glacial conglomerate is described as being at least 200 feet thick, and as having sandstone interstratified with it.

Mr. Dunn was fortunate enough to discover a powerfully striated rock surface near Derrinal, the grooves trending north and south. This surface, he thinks, was grooved by floating ice. He describes in detail the large granite erratic known as the "The Stranger," and weighing about thirty tons. He is cautious as to expressing any opinion as to whether the ice came from the south or from the north. Many of the boulders in the moraine, he states, are unlike any rocks found now in Victoria.

The level of the upper portion of the conglomerate is about 700 feet above the sea, but the base of it must be many hundreds of feet lower.

In 1892 Mr. Dunn, in company with Mr. T. B. Moore, discovered evidences of ice-action on the high plateau in the neighbourhood of Mount Dora, in Tasmania.

In 1893 Mr. E. J. Dunn published an account of the glaciation of Lake Dora, which is twelve miles distant from Zeehan, on the west coast of Tasmania, and 2,500 feet above sea-level.†

There are evidences there of glacial deposits belonging to two distinct periods—(1.) An ancient glacial conglomerate like that of Wild Duck Creek, in Victoria, 3,000 feet above sea-level, the included boulders of which are beautifully striated (*op. cit.*, p. 138). (2.) Far newer and comparatively recent moraines and striated pavements. The latter, near Lake Dora, show the valley to have been filled with ice to a depth of at least 400 to 500 feet.

At Lake Rolleston there is a large terminal moraine 150 feet high and 250 feet wide, some of the blocks of which it is composed being over 100 tons in weight.

The lowest altitude to which glaciation extended was probably about 2,000 feet (*op. cit.*, p. 137).

Further evidences of glaciation in Tasmania have been described by Mr. T. B. Moore, who states that at Mount Tyndall the surfaces of

* "Notes on the Glacial Conglomerate of Wild Duck Creek," by E. J. Dunn, F.G.S. Special reports, Department of Mines, Victoria. By authority: 1892.

† Proc. Roy. Soc. Vic., 1893, pp. 133-138, plate viii.

the conglomerate rock, probably Devonian, are powerfully striated and well polished to within 20 feet of the summit of the mountain, the elevation of which is 3,850 feet. Morainic material was observed by him at the above locality down to a level of between 2,182 and 2,400 feet above the sea.

Mount Sedgwick is stated to have been glaciated to within a short distance of its summit, the altitude of which is 4,000 feet.

The chief direction along which the ice has moved has been from N.E. to S.W.*

Mr. T. B. Moore states (*op. cit.*, p. 148) —" At an elevation of 3,500 feet above sea-level, adjoining the greenstone on the south-east side of the Mount—[Tyndall—T.W.E.D.]—I was pleased to discover a bed of glacial conglomerate containing coal-measure fossils. The pebbles are scored in all directions, and many beautifully polished. The conglomerate is composed of rocks quite foreign to the country—granites, slates, porphyry, &c.—and as they occur at such a high elevation, embedded together, intermixed with Carboniferous fossils, and the pebbles scored before the mass was consolidated, there is not the slightest doubt that the conglomerate has been formed from the *debris* deposited by floating ice when the land was under water. This also points to the fact that the deposit was laid down at a previous period to the epoch of the land glaciation." He states (*op. cit.*, p. 148) that the moraines to the west of Lake Margaret are the most extensive observed by him, and rise from 200 to 300 feet above the lower valleys.

In 1893, Mr. A. Montgomery, the Government Geologist, considerably extended our knowledge of the glaciation of Tasmania in Pliocene or Post-Pliocene time by a very interesting description of evidences of ice-action at the head of the River Forth, at Barn Bluff, and at Mount Pelion.†

The evidence is described as consisting of moraine stuff, and singularly perfect *roches moutonnées* and erratics at the 2,000 feet to the 2,792 feet level near Lake Eyre (in Tasmania).

Mr. Montgomery (*op. cit.*, p. 161) questions the accuracy of Mr. T. B. Moore's opinion as to the glacial conglomerate at Mount Tyndall being of Permo-Carboniferous Age, and suggests that it may be a redistributed Permo-Carboniferous conglomerate, glaciated perhaps, in Tertiary times. He states that near East Mount Pelion *roches moutonnées* are very well developed, and that erratics and striated rock surfaces are frequent, the movement of the ice having been from north to south; that the greenstone erratics are very little decomposed, and that the ice-worn rock surfaces are in a splendid state of preservation—arguments in favour of a Pleistocene rather than a Pliocene Age for the glaciation, as also is the good state of preservation of fragments of Permo-Carboniferous cannel coal in the moraines (*op. cit.*, p. 163).

In 1893, Messrs. Graham Officer and L. Balfour published a paper on the Bacchus Marsh Conglomerates.‡ This paper is well illustrated by photographic plates. They were led to believe that there was evidence at Bacchus Marsh of glaciations belonging to two

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* "Discovery of glaciation in the vicinity of Mount Tyndall, Tasmania," by T. B. Moore. Papers and Proc. Roy. Soc. Tasmania, 1893, pp. 147-149.

† Papers and Proc. Roy. Soc. Tasmania, 1893, p. 30.

‡ Proc. Roy. Soc. Victoria, vol. v., new series, pp. 45-68, pls. x., xii., 1893.

distinct periods—the one in Tertiary, the other in Triassic or Permo-Carboniferous time. They considered the striation and grooving of the rock pavement had been accomplished by land glaciers, which had left behind them a moraine *profonde*. In a later paper, however, these authors frankly withdrew their statement as to there being evidence there of a Tertiary glaciation, referring all the phenomena to the action of ice during one particular geological period, the Permo-Carboniferous or Triassic.*

In September, 1893, Messrs. G. Sweet and Charles C. Brittlebank contributed an able paper on the Glacial Deposits of the Bacchus Marsh District. They sum up (*op. cit.*, pp. 388-9) as follows†:—"The evidences appear to us to support—

I. The reference of the early noticed conglomerates by the first and able geologists of the Geological Survey of Victoria, and of the present departmental officers, and Mr. Oldham, of the Indian Geological Survey, to their deposition under water by the agency of floating ice near shore, and to their final arrangement by the moving waters.

II. Also, the theory that the sandstones and mudstones and other conglomerates intercalated between these, but lying to the north, east, and west of them, including those known as the Bacchus Marsh Triassic Sandstones, have been laid down under water, and probably belong to the same great deposit, and have resulted from similar causes. The beds now dip in a general southerly direction towards the present sea.

"Further, that as far as has yet been observed, these rocks contain no direct evidence of glaciers having passed down these valleys or over this area in Tertiary times, and that there does not exist, so far as has yet been observed by us, a moraine *profonde* to prove the existence of such a glacier moving down the valley from the Dividing Range at any time. It will be remembered that the general direction of the grooves and striæ, so far as observed by us, are from S.W. to N.E., or *from* the present sea."

They estimate the thickness of the glacial beds at about 5,000 feet, and have determined their altitudes as ranging from 700 feet to 1,400 feet above the sea.

Writing to me on 4th December, 1894, Mr. Charles C. Brittlebank thus states his conclusions as to the nature of the glaciation of the Bacchus Marsh District in late Palæozoic or in early Mesozoic time—"That land ice came from the S.S.W. to the N.N.E. This was either a continuation of the Antarctic ice-cap or immense glaciers from land south of Australia. After a considerable period of time, one of sufficient length to allow the ice to grind the older rocks into hollows, furrows, ridges, and planed surfaces, a subsidence of several thousand feet took place. It was during this sinking that the sandstones, mudstones, and conglomerates were laid down by the aid of sub-glacial streams and floating ice. This latter no doubt carried the boulders which are seen in the stratified sandstone. By the above theory it will be seen that the land was to the south, and the sea to the north.

* Proc. Roy. Soc. Victoria, vol. vi., new series, 1894, pp. 139-143.

† Rep. Austr. Ass. Advt. Sci. Adelaide, 1893, pp. 376-389.

For the above it is necessary to suppose that the ice-front entered the sea." Reference will be made to this ingenious theory of Mr. Brittlebank further on.

In 1893 Captain F. W. Hutton contributed an able and detailed report, as member of the Research Committee appointed to collect evidence as to glacial action in Australasia in Tertiary or Post-Tertiary time, on the ancient glaciers of New Zealand.*

He shows on his map that during the great Glacier Period of New Zealand, which dated, he considers, as stated elsewhere, as far back as perhaps early Pliocene time, the area occupied by glacier ice and snowfields was at least (according to my approximate estimates from his map) twenty times as much as the area at present covered by snow and glaciers. The Wakatipu glacier attained a length of eighty miles during the Glacier Period, whereas the largest modern glacier in New Zealand—the Tasman—is only eighteen miles in length. The ancient glaciers on the west coast of the South Island descended below the *present* [the italics are mine] sea-level, but there is no evidence that they ever reached the sea, an argument obviously in favour of the land having stood higher than it does now, at the time when the glaciers attained their maximum development. Captain Hutton concludes (*op. cit.*, p. 240)—"The biological evidence is therefore to the effect that the ocean round New Zealand has not been much colder than at present ever since the Miocene Period."

A short summary of evidences of glacial action in Australia and Tasmania in Tertiary or Post-Tertiary time is furnished by myself in the same volume (*op. cit.*, pp. 229-232).

In 1894 Mr. Richard Helms communicated a paper to the Linnean Society of New South Wales on the recently observed evidences of an extensive glacier action at Mount Kosciusko plateau.†

He claims to have discovered traces of terminal moraines, and states (*op. cit.*, p. 353)—"All the moraines observed by me end towards the east or south-east; at any rate, it is plainly demonstrable that the ice moved from a westerly direction." At Lake Merewether he discovered a distinct moraine dam (*op. cit.*, p. 357) resembling an artificially heaped up railway embankment, about 100 feet above the valley. He discovered that much of the snow was rendered pink by an alga perhaps allied to *Protococcus nivalis* (*op. cit.*, p. 361). "These algæ live most luxuriantly and very abundantly a few inches below the surface, and when the dirty granulated crust of the snow is removed to the depth of an inch or two the sight is surprising and pleasing. The disclosed part reveals a beautifully fresh crimson colouring speckled with pure white snow granules, that resembles the hue of a freshly-cut ripe watermelon." At Boggy Plain the altitude of the morainic material is said to be as low as 5,200 feet. Mr. Helms exhibited a beautifully striated rock fragment about 10 inches in diameter, obtained by him from the Kosciusko plateau.

In November, 1894, Mr. T. S. Hall contributed a note on the bibliography of the Bacchus Marsh Glacial Deposits,‡ in which he emphasises the fact that Daintree found striated boulders at Bacchus Marsh in 1866.

* Rep. Fifth Meeting Austr. Assoc. Adv. Sci. Adelaide, 1893, pp. 232-240, with one plate.

† Proc. Linn. Soc. N.S.W., second series, vol. iii., pt. 3, pp. 349-364, with plate xviii., 1894.

‡ The Victorian Naturalist, Melbourne, 1894, pp. 125-128.

(2.) Recent Observations by the Author.

A.—Bacchus Marsh District.

During December, 1894, I had the advantage of the guidance and help of Messrs. G. Sweet and Chas. C. Brittlebank when examining a portion of the glacial beds at Bacchus Marsh.

Bacchus Marsh is a small town, distant thirty-two miles W.N.W. from Melbourne, and 343 feet above sea-level. The surface of the country rises gradually from the town to the undulating plateau of the Pentland Hills.

Their outlines are smooth and flowing, notched here and there by valleys eroded to depths of from about 300 to 500 feet. The plateau slopes gently to the south-east towards the plains of Melbourne and Geelong. Looking southwards the observer sees the Yoyangs, hills of granite of considerable height, boldly outlined against the sky. Northwards the plateau culminates in the small dome of Mount Blackwood, an extinct volcano. Most of the country has been cleared and apportioned into farms, whose comfortable-looking homesteads here and there nestle among orchards and clusters of trees. Post-and-rail fences fitted with barbed wire divide the paddocks, which at the time of my visit were covered with grass, thin and sere from the summer heat, giving the hills a pale umber hue, save where they were patched with the yellow and green of ripening crops of oats. At intervals a thick clump of Scotch thistles made those of us whose legs were unfortified by gaiters walk warily. Every now and then the white scut of a retreating rabbit twinkled among the brown stems of the bracken lining the banks of Myrniong Creek; and once our noses made us aware that an English fox was close at hand, and presently we sighted him creeping stealthily below some ledges of rock high above our heads.

The country is drained by the Korkuperrimal Creek on the east, Myrniong Creek in the centre, and Pykes Creek on the west. They are all tributaries of the Werribee River. The general fall of these creeks and of the Werribee River is towards the south-east. Mr. Brittlebank pointed out to me excellent sections in the banks of Myrniong and Korkuperrimal Creeks and in those of the Werribee River.

The formations represented are as follows:—

(1.) *Recent.*—Alluvial gravels, rubble, &c., on the banks of the creeks and rivers.

(2.) *Pliocene* (?)—Sand, clay, and gravel overlying newer basalt. Thickness about 30 feet.

(3.) *Pliocene.*—Newer basalt. Thickness about 100 feet.

(4.) *Lower Miocene or Eocene* (?)—Sand, clay, quartz, gravel, and sandy dark-brown ironstone, containing *Laurus Werribeensis* and fossil fruit. Total thickness 300 feet to perhaps at least 500 feet.

(5.) Older basalt perhaps interstratified with the above. Thickness (?)

(6.) *Permo-Carboniferous* (?)—Glacial beds. Thickness estimated approximately by Messrs. Sweet and Brittlebank (*op. cit.*, p. 388) as 5,000 feet. The portion examined by me in Korkuperrimal Creek showed a thickness of at least 3,500 feet, provided the beds are not repeated by faulting. These beds consist of—

(i.) Hard mudstones with small well-glaciated boulders. The groundmass is brownish-grey. Described by Messrs. Daintree and Wilkinson as light claret-colour where weathered, and as bluish-grey at a depth. It is composed partly of clayey material, partly of quartz grains, mostly subangular, but a few well-rounded. A small proportion of fragments of undecomposed felspar, and minute chips of black shale are present, together with small pieces of carbonised plants. The diameter of the boulders varies from a few inches up to 5½ feet, but that of most of them is less than a foot. None observed by me were absolutely angular, all being subangular or rounded. Several of the boulders, which are most powerfully glaciated, are flattened on one side like a holystone. Well-rolled pebbles, faceted or simply faced by having had one side rasped down, are frequently noticeable, some of the smaller ones presenting the appearance of having been literally half ground away, as if on a grindstone. They are very firmly bedded in the groundmass, as though the whole had been subjected to considerable pressure. The thickness of individual beds of this formation varies from about 20 feet to 40 feet.

(ii.) Conglomerates, greenish-brown and lithologically resembling those of Newcastle, in New South Wales, composed of well-rolled pebbles from an inch or so up to 6 inches in diameter, with, rarely, large glaciated erratics. The conglomerates in places, as at the elbow of Myrniong Creek, about half a mile below Dunbar, the residence of Mr. Brittlebank, make a very uneven junction line with the bouldery mudstones underlying them, as shown in the photograph exhibited, suggestive of their having been squeezed down by pressure from above, so as to form pockets in the underlying mudstones. The thickness of individual beds varies from 8 feet up to about 50 feet.

(iii.) Sandstones, brownish to whitish-grey, in places finely laminated, or showing distinct ripple mark. When finely laminated the laminæ exhibit a remarkable amount of contemporaneous contortion. The more massive varieties of soft brownish-grey ferruginous sandstone contain leaves of *Gangamopteris* in tolerable abundance on possibly two distinct horizons, neither of which can be less than 3,000 feet above the base of the glacial beds. Fragments of plants, identified by Sir Frederick McCoy as *Schizoneura* and *Zeugophyllites*, have been obtained from a bed of sandstone close to the top of the glacial series on the east of Korkuperrimal Creek, above the small quarry. The angle of dip varies from a few degrees up to over 45° in the upper portion of Korkuperrimal Creek, being southerly at from about 43° to 45° for a distance of nearly three-quarters of a mile at right angles to the strike. The direction of the dip is easterly at the *Gangamopteris* quarry, on the lower portion of Korkuperrimal Creek, and also at the Werribee Gorge, the angle varying from about 5° up to 27°. Strong unconformability follows.

(7.) *Post-Ordovician and Pre-Permo-Carboniferous Granite.*—This rock has intruded the Ordovician strata, but is clearly older than the glacial beds, which, where resting on it, are largely composed of pebbles and finer material derived from its waste. Along the junction line of the granite pavement with the glacial boulder beds the rock has in most places become too rotten to retain striæ or grooves; but traces of these are beautifully preserved in the form of casts on the under surface of the hard boulder beds, which have better resisted the tendency to decay.

(8.) *Lower Silurian* (Ordovician).—Black slates and shales, with *Graptolites* and grey quartzites and felspathic quartzites. These strata have been intruded by the granite mentioned above, and have been powerfully folded, their bedding planes in many places being vertical. The strike is N. 10° E., at the Werribee Gorge, but the general strike, as shown on Sweet and Brittlebank's map, appears to be nearer N.E and S.W. Wherever the covering of glacial beds has been recently denuded or artificially removed from the surface of these strata, a grooved and striated pavement is exposed to view. These have been noticed by Messrs. Sweet and Brittlebank at intervals over the 130 square miles of country examined by them.

Glaciated Pavements.—In the Werribee Gorge the surface of the glaciated pavement is very uneven, on a large scale presenting deep troughs bounded by slopes of over 70 degrees, or even by vertical cliffs, the troughs being separated from one another by rounded ridges rising to over 400 feet in places above the deepest portion of the pavement exposed in the troughs. Not only are the flatter portions of the pavement glaciated, but even the steep slopes are deeply grooved, striated, and furrowed. Where, as in the Werribee Gorge, the strata composing the pavements are made up of alternating beds of hard quartzites and soft clay shales, the surface somewhat resembles, though on a larger scale, a sheet of corrugated iron; for the quartzite beds, having resisted abrasion better than the clay shales, project as rounded ridges from six inches to one foot wide, and separated from one another by grooves two to four inches wide, and of about the same depth. In this case the striæ and grooves prove that the ice moved almost exactly parallel with the strike of the nearly vertical Silurian strata—the direction which would, of course, offer the greatest facilities for the unequal wearing of the hard and soft layers. Small hollows, presenting a rough or only slightly striated surface, showed where pieces of the pavement had been forced off by the moving ice, the fragments so dislodged being wedge-shaped, and it was noticeable that the thick end of the wedge invariably pointed to the south. The hollows occurred immediately to the north of joints crossing the Silurian strata in an east and west direction. The north side of these east and west joints was, therefore, evidently the *stoss-seite*. An examination of projecting points and ledges of the pavement confirmed the supposition that the ice moved here from south to north, as argued by Sweet and Brittlebank. The general trend of the grooves and striæ is about from S. 12° W. to N. 12° E. At the lower end of the gorge the level of the glaciated pavement is about 660 feet above the sea, whereas in the Lerderberg Ranges, to the east of Korkuperrimal Creek, it is (*f.* Brittlebank) 1,400 feet above the sea.

The distance of Werribee Gorge from the sea, at the nearest point, is about thirty miles.

On the left bank of the Werribee River, opposite Daintree's Cliff, are some wonderful examples of casts of the glaciated pavement taken by the glacial beds.

The pavement, which was there composed entirely of soft clay slate, has weathered away for several feet inwards from the face of the cliff, so as to leave a space of a few inches between its weathered surface and the base of the overlying glacial beds. The under surface of the latter has preserved exquisitely the casts of the grooves, furrows, and even delicate striæ with which the surface of the Silurian slates were once covered. The observer cannot fail to be specially struck by the remarkable freshness of the appearance of the striæ and grooves on the included boulders in the glacial beds, as well as on the glaciated pavements. Hand specimens of either might easily be mistaken for examples of glaciated rocks of Pleistocene age from Europe or America, and yet it is certain that the date of this Australian glaciation dates at least as far back as the commencement of the Mesozoic era, and probably the close of the Palæozoic.

Erratics and Boulders.—These are composed of whitish to greenish-grey, red, and brown quartzite, felspathic quartzite, quartz-felsite, reddish quartz-grit, claystone, dark clay slate, mica-schist, granite, quartz, gneiss, &c. Daintree commented on the fact that (v. *supra* p. 61) the nearest spot to this locality where mica-schist occurred *in situ*, as far as he knew, was on a branch of the Glenelg River, which is about 140 miles distant W. by N. He states that "the peculiar characters of some of the granites are unknown in Victoria." Mr. E. J. Dunn (v. *supra*, p. 72) concludes that much of the material—[*i.e.*, in the Permo-Carboniferous glacial beds of Victoria—T.W.E.D.]—is foreign, and many of the rocks are not known to occur at present in this continent anywhere near Victoria.

B.—Derrinal.

At Derrinal, near Heathcote, in Victoria, Dr. F. S. Bond kindly conducted me over some of the principal sections, and Mr. Hollingsworth exhibited to me a large collection of small erratics collected by him from the local glacial drifts. Although no fossils have as yet been found in the glacial beds at this locality, the lithological resemblance to the Bacchus Marsh Beds is so strong that there can be little doubt, in my opinion, as to their contemporaneity. Here, as at Bacchus Marsh, are mudstones with boulders, conglomerates, and sandstones, probably of Permo-Carboniferous age, and reposing on a glaciated pavement of Lower Silurian rocks. The glacial beds occupy a trough or valley in the Lower Silurian rocks, and have been traced by Mr. Dunn fifteen and a-half miles in a north and south direction with an extreme width of five miles. Large erratics are more common here than at Bacchus Marsh. The largest of these, "The Stranger," a photograph of which, taken by me, is now exhibited, was estimated by Mr. E. J. Dunn to weigh about thirty tons. It is composed of coarse granite. On examining this erratic I noticed that part of the top was traversed by a groove 2 feet wide by 6 inches deep. The trend of this groove is about N. 10° W., and that of some other smaller grooves varies from N. 3° W. to N. 10° W. The lie of its longest axis is N.W. and S.E.

The upper surface dips E. 30° S. at about 26°. As the surface slope of the ground is in the same direction, it might seem reasonable to suppose that the erratic had been gradually undermined by weathering, and had crept down the slope of the hill. Such, however, I venture to think, is not the case. The erratic appears to be still firmly imbedded in the glacial strata, and the dip is therefore, on this supposition, original. On this hypothesis the grooves were scored on its surface by ice passing over it subsequent to the time of its becoming imbedded in the mudstone. Bearing W. 40° S. from "The Stranger," and seventeen yards distant, is another erratic, composed of dark greenish-grey quartzite. The lie of its longest axis is N. 25° W., and the trend of its grooves is in the same direction. As regards the parent rocks, from which these erratics may have been derived, Mr. Dunn states (*op. cit.*, p. 3)—"Among the boulders, &c., many are recognisable as derived from the sandstone and conglomerate beds of Devonian age, such as occur in Gippsland;" and again (*op. cit.*, p. 4)—"Rocks similar to the Upper Silurian, and to the old jaspery beds of MacIvor Range, are common in the conglomerate, but it does not follow that even they are of local origin; but many of the granites, &c., are not known in Victoria, and may have been transported for enormous distances." Mr. A. W. Howitt, in a letter to me on the subject of these erratics, states—"I was, however, struck by the appearance of the boulders, pebbles, &c, at Derrinal as being quite, as a collection, unknown to me from any part of Victoria nearer than the mountains of North Gippsland." The MacIvor range lies over twenty miles to the S.E. of Derrinal, and North Gippsland is from 120 to 150 miles to the E.S.E.

It appeared to me probable that the material had been brought through the low gap between Mount Alexander and Mount Macedon. Some of the granite composing the erratics near Derrinal appeared to me to closely resemble the Harcourt granite, which occurs *in situ* twenty miles to the W.S.W. At "Dunn's Rock," near Derrinal, the surface of the Lower Silurian sandstone has been planed down and strongly furrowed in a direction N. 7° W. A careful examination of this rock led me to the conclusion that the ice which had caused the grooving had probably moved from the south, as the sandstone bed, which there forms the apex of an anticlinal curve, has been very strongly abraded at the southern end of its outcrop. The greatest altitude attained by the glacial conglomerate is stated by Mr. Dunn to be 700 feet above sea-level, and it must descend to at least 300 or 400 feet lower (*f.* Dunn). The elevation of Dunn's Rock is shown on his section as about 750 feet above the sea. A bed of sandstone, 60 to 70 feet thick, is interstratified with the boulder-bearing mudstone.

C.—Hallett's Cove, near Adelaide.

As a detailed account of evidences of glacial action at this spot is given in the Report of the Glacial Committee of this Association, a brief summary will here suffice. Hallett's Cove is distant about fifteen miles S.S.W. from Adelaide. The chief formations represented there are—(1) Pre-Cambrian, (2) the glacial beds of Post-Carboniferous and Pre-Miocene age, (3) Miocene marine beds capped by non-fossiliferous clays.

A striated pavement of archæan rock extends for at least a mile along the coast, dipping below sea-level, and extending to over 100 feet above the sea. The grooves trend chiefly nearly due N. and S., but in places are nearly N.W. and S.E. The ice which produced them moved from south to north.

The glaciated pavement is capped in places by glacial beds 23 feet to over 100 feet in thickness. These are laminated, and contain glaciated boulders sparingly in their upper portion; but in their lower portion glaciated boulders abound, associated with occasional, large, worn erratics, some at least eight tons in weight. The erratics have probably been carried from the south. The sand grains in the groundmass of the glacial beds are intensely waterworn—a fact very suggestive of a marine origin. Although no marine organisms have as yet been detected in these glacial beds, I think it not improbable that they represent sea sands, though it is of course conceivable that they are used grains derived from an old marine sandstone. The groundmass is clearly of local origin, as are many of the small boulders. Most of the large erratics, however, have travelled from some distance, perhaps from localities thirty to forty miles to the south. The glacial beds are capped by Miocene strata, the junction line between the two formations being an eroded one. The glaciation of Hallett's Cove may, perhaps, be correlated with that of the Inman Valley, near Port Victor, South Australia; with that of Curramulka in Yorke Peninsula, South Australia; and with that of the Bacchus Marsh and Derrinal districts in Victoria. It may, however, of course be referable to any geological age intermediate between that of Miocene and Carboniferous.

(3.) Correlation of the Glacial Deposits.

On lithological grounds it is extremely probable that the glacial beds of Bacchus Marsh, Wild Duck Creek, and of Beechworth, in Victoria, were homotaxial, if not of contemporaneous origin, and probably also homotaxial with the older glacial conglomerates of Mount Reid and Mount Tyndall, in Tasmania. The occurrence of several varieties of *Gangamopteris* in the Bacchus Marsh beds of Victoria suggests the correlation of the latter with the mudstones containing erratics at Maria Island and One Tree Point, Bruni Island, Tasmania; with the similar beds at Marangaroo, Maitland, Branxton, and Grasstree, in New South Wales; and with those of the Bowen River Coal Field of Queensland. The evidence for this is that *Gangamopteris spathulata*, McCoy, has been found in Tasmania associated with the mudstones containing large erratics*; and the same species occurs in the glacial conglomerates of Bacchus Marsh. In New South Wales *Gangamopteris* is very abundant in the Middle Coal Measures (Tomago) of the Permo-Carboniferous system. It is also plentiful in the Lower Coal Measures (the Greta), but in the Upper Coal Measures (the Newcastle) *Glossopteris* predominates. In the Greta Coal Measures *Gangamopteris* and *Glossopteris* are sandwiched in between the erratic-bearing mudstones of the Lower Marine series, and those of the Upper Marine series of the Permo-Carboniferous system, both of which contain an abundant marine fauna of Permo-Carboniferous affinities. *Gangamopteris*, in Tasmania, is associated with a similar marine Permo-Carboniferous fauna.

If, therefore, this correlation be conceded, ice of some kind made itself manifest in Permo-Carboniferous time in the Australasian region

* Papers and Proc. Roy. Soc. Tasmania, 1893, p. 34.

from Zeehan, in lat 42° S., to the Bowen River Coal Field, in lat. 20° 30′ S., and from long. about 137° 30′ E. (Curramulka) to about 151° 30′ E. (Maitland). In Victoria hundreds, probably several thousands, of square miles are still covered by the glacial beds, and doubtless far larger areas formerly glaciated have had all traces of glaciation removed by denudation.

This early glaciation of the Australasian region was probably homotaxial with that of Southern Africa and Southern India. In Southern Africa Mr. G. W. Stow and Dr. Sutherland have described glaciated blocks associated with the Karoo or Ecca Beds; and Professor A. H. Green* has referred the erratics in the Dwyka conglomerate to glacial action. Mr. E. J. Dunn, as long ago as 1872, discovered glacial conglomerates, subsequently known as the Dwyka conglomerates, at Weltevreden's farm, near the junction of the Vaal and Orange Rivers; and in 1885 he made the important discovery of a striated pavement at the junction of the above rivers, and ascertained that the movement of the ice had been from south to north. The level of this pavement, as he informs me, is less than 1,000 feet above the sea. The shales underlying the large boulders in the conglomerate, as he states, are distinctly indented. This is in lat. 29° S., long. about 23° 40′ E. A specimen of *Gangamopteris*, 5 inches in length, was found by Mr. Dunn in the Lower Karoo beds above the Dwyka conglomerates. In Southern India evidence of glacial action in Permo-Carboniferous time has been observed in the Talchir Group, in the Salt Range Group, the boulder beds at Bap, in Western Rajputana, and the Panjáh conglomerates of Kashmir†‡ Mr. Fedden states that at ten miles west-south-west from Chanda,§ near the little village of Irai, the Talchir boulder beds rest upon compact Perm limestones [Lower Vindhyan (older Palæozoic)—T.W.E.D.]. "For a length of 330 yards along the river bank this underlying rock is exposed, displaying a large surface, polished, scratched, and grooved after the fashion so familiar to glacialists. The surface has a slope of 12°-15° to the west, obliquely overcutting the strata, which have a dip of 8° to the west-south-west. The striæ and grooves run in long parallel lines, having directions between north-east and north-north-east, oblique to the slope of the surface; and from the manner in which the rock is affected at the edges of a few planes of jointing, it can be inferred that the movement was up the slope. * * * The actual conditions are so far confirmatory of the view we have been led to -of an ice raft being drifted against and impelled up an opposing rock surface. * * * It would appear that the freighted ice mass had travelled a long distance from the south-west through the Utnúr and Endlabád (Idulabad) districts, where rocks occur of the same composition as that of the several boulders."

The latitude of Irai is 19° 53′; elevation under 900 feet. The most southerly position of the Talchir boulder bed is latitude 17° 20′, and only a little above the level of the sea.

* Quart. Journ. Geol. Soc. London, vol. xliv., 1888, p. 233.

† Geology of India, second edition. Stratigraphical and Structural. R. D. Oldham; pp. 120-121, 124, 135, 157-160, 198-201, &c.

‡ T. Oldham, Memoirs Geol. Sur. India, ix., p. 324, 1872; and W. Blanford, pp. 27-31.

§ Records Geol. Sur. India, viii., p. 16, 1875.

Near Pokaran there is a similar smoothed and striated pavement, which is stated to exhibit in addition typical *roches moutonnées*. (R. D. Oldham, *op. cit.*, p. 160). The marine fauna associated with the Talchir beds, and partly underlying, partly overlying the boulder beds, proves them to be homotaxial with those of Eastern Australia and Tasmania. Mr. R. D. Oldham states (*op. cit.*, p. 120) that the parent rocks of some of the erratics in the Talchirs are probably 750 miles to the south. The largest blocks are 15 feet in diameter, and weigh thirty tons (*op. cit.*, p. 157).

As an argument in favour of the upper portion, at all events, of the Bacchus Marsh beds being, perhaps, of Triassic rather than Permo-Carboniferous age, the fact may be repeated here that Professor McCoy has identified fragments of plants from near the top of the glacial beds as belonging to *Schizoneura* and *Zeugophyllites*. Neither of these have as yet been traced as low down as the Permo-Carboniferous horizon in New South Wales; but the former occurs in the above colony at the base of the Triassic Hawkesbury Series at Bulli.*

It is also singular that, if the marine Permo-Carboniferous beds of Tasmania, New South Wales, and Queensland are homotaxial with the Bacchus Marsh beds of Victoria, in which latter glaciated boulders abound, no single instance of an undoubtedly glaciated erratic should have been met with as yet in the former. The contemporaneously contorted bedding in the Triassic Hawkesbury Series of New South Wales, being remarkably like that observable in the sandstones of Bacchus Marsh, is also an argument for a correlation of the Bacchus Marsh Glacial beds with the Trias rather than with the Permo-Carboniferous.

(I.) Antarctic Icebergs.

As the theory that the glacial phenomena in Australia and Tasmania, in late Palæozoic time, are due to floating ice, appears to have found most favour with Australian geologists, reference may be made here to Antarctic icebergs, their work, and direction of drift.

A glance at Plate I., attached to this address, shows that the northern limit of iceberg drift in the Southern Hemisphere is about lat. 38° S., the northernmost point to which icebergs are drifted being a short distance south of the Cape of Good Hope.

Huge strips of ice, in some cases over fifty miles long, but usually cracked across, so as to form a belt of individual bergs, and half a mile or more in width, and 1,700 to 1,800 feet thick, are constantly being launched from the front of the great ice barrier of the Antarctic ice-cap.

These bergs are very numerous, and of large size in the neighbourhood of Cape Horn, as will appear from the following account (kindly placed at my disposal by Mr. H. C. Russell, Government Astronomer of New South Wales) by Mr. W. R. Woodget, captain of the "Cutty Sark":—

"'Cutty Sark,' Sydney towards Antwerp. Left Sydney 7th January, 1893. * * * * After rounding the Horn on February 8th, lat. 50° 08′ S., long. 46° 41′ W., we ran in amongst a great number of icebergs of all sizes and shapes; one I estimated to be 1,000 feet high. It came in

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* Records Geol. Survey, N.S. Wales, vol. iii., pt. iii., 1893, pp. 74-77, with plate xii., "On the occurrence of a plant allied to *Schizoneura* in the Hawkesbury Sandstone," by R. Etheridge, junr.

thick; we could hear the sea roaring through and on them, and hear the ice grinding one against the other. Sometimes you would hear loud reports like an 80-ton gun being fired, but we groped along, as it were, in the dark, hard up and hard down to clear one after the other. By this time the water was quite smooth, like being in a dock, and then we discovered one large one ahead. We sailed eight miles alongside of this, but did not see the end, and then another appeared ahead, so I had to go between them after a while with ice on both sides. As we sailed slowly along, all eyes watching for a passage, soon the fog lifted, and we saw a narrow passage about 1,000 feet wide, with ice on either side 400 feet high. As we cleared the passage it was quite clear, and from cross bearings and from distance run I found one side to be 19½ miles long, quite flat."

The iceberg considered to be 1,000 feet high must surely have been of irregular shape, if its height was not over-estimated, as, if rectangular, it would have needed about 1,500 fathoms of sea water to float it, and its total thickness would have been 10,000 feet. Captain Woodget presumably could not have been much mistaken in his calculations as to the height of the huge tabular berg 19½ miles long being 400 feet, as he passed within a few hundred feet of the ice-cliffs which bounded it. He does not, however, state that he took any angular measurements of its height. If his estimate was correct, this iceberg must have been about 4,000 feet thick.

A strong current carries the bergs to the east-north-east after they leave Cape Horn, the current being due partly to the strong west winds known as the "Roaring Forties," or "Brave West Winds," to the south of the anti-cyclone belt, partly to the circulation set up by the differential heating by the sun of the water at the equator as compared with that near the poles. Between Cape Horn and the Cape of Good Hope this easterly current is pulled northwards until it divides at the Cape, where part of it flows northwards along the west coast of Africa as the Benguela current, while part continues easterly from the Cape of Good Hope towards Australia. It will be noticed, however, that the line limiting the drift of icebergs northwards is (east of the Cape) pushed down somewhat to the south by the warm water of the Agulhas current.

That large icebergs are still met with for a considerable distance to the E.S.E. of the Cape of Good Hope is shown by the narrative supplied by the captain of the steel barque "Lodore."* The first ice was seen by those in the "Lodore" in lat. 45° S., long. 20° E., and the bergs are stated to have been from 500 to 800 feet high, and to have been met with at intervals for a distance of 1,500 miles from the spot mentioned towards Australia, the last being seen in long 40° E. It cannot, of course, be proved that any of these icebergs have come from a longitude west of Cape Horn, as some of them may have been derived from the ice barrier anywhere between Graham Land and the so-called Termination Land of Wilkes.

As the south-west extremity of Australia is approached, part of the great easterly ocean current turns northwards along the west coast of Australia, just as the Benguela current does on the west coast of Africa.

* The *Daily Telegraph*, Sydney, 19th February, 1894, p. 7.

This leads to the line limiting the iceberg drift bending here slightly to the north. Further east, however, as shown on Plate I., the line is strongly indented southwards by the warm southerly current along the east coast of Australia. The observations of Sir James Ross, when added to those made on the "Challenger," show that on the whole, from that area of the Southern Ocean which lies between the longitudes of Termination Land and Terre Adélie, the currents set about E.N.E., and on nearing Tasmania they set about N.N.E., making towards Melbourne. Recent bottle experiments, the results of which have been published by Mr. Wragge, show that there is a current setting around the Great Australian Bight from near Kangaroo Island to Cape Arid in West Australia. I mention this to show the possibility of granites and gneisses such as those of which Terre Adélie is composed being carried by icebergs towards the southern shores of Australia.

If our attention be directed once more to the line limiting the northward drift of bergs, it will be observed that after bending down as far south as the Macquarie Islands and Campbell's Island, in, approximately, lat. 53° S., it trends rapidly to the N.N.E., passing through the Chatham Islands in lat. 44° S., and attaining a latitude of about 42° S. at a point about 250 miles east of those islands. Within the last two years two icebergs have actually grounded at the Chatham Islands, as I am informed by Mr. H. C. Russell. Icebergs have been seen near Cape Agulhas, the southern extremity of Africa, as already stated, and this is in lat. 34° 9′ S. Under existing conditions, therefore, of climate and ocean currents, icebergs in the Southern Hemisphere attain a latitude of about 35° S.

Now, if there were continuous land from Tasmania to Victoria Land, the Southern Ocean west of this barrier would cease to be warmed by the east Australian current, and a strong Antarctic current would be set up corresponding to the Benguela current off Africa, and the Peruvian current off the west coast of South America. This would carry icebergs, even under existing conditions of climate, at least as far north as the 35th parallel—that is, the icebergs would be carried probably far north of the latitude of Melbourne, to that of Adelaide and Wagga; and the whole area of Victoria, if submerged, would be liable to be invaded by fleets of icebergs, and even now their vanguard can almost be sighted from the southern hills of Tasmania.

It may be questioned, however, whether Antarctic icebergs, if stranded over those areas of Eastern Australia, where traces of Permo-Carboniferous glaciation are now observable, would be competent to produce such glacial phenomena.

As regards the nature of the deposits now being laid down on those portions of the sea-floor which come within the range of the Antarctic ice-sheet and Antarctic bergs, the observations of Sir James Ross and of the "Challenger" Expedition are of great interest.

Sir James Ross* states that when off Victoria Land, "Whilst measuring angles for the survey, an island I had not before noticed appeared, which I was quite sure was not to be seen two or three hours previously. It was above 100 feet high, and nearly the whole of the summit and eastern side perfectly free from snow. I was much surprised at the circumstance, and on calling the attention of

* Voyage to the Southern Seas, vol. i., p. 195.

some of the officers to it one of them remarked that a large berg which had been an object of observation before, had disappeared, or rather had turned over unperceived by us, and presented a new surface, covered with earth and stones, so exactly like an island that nothing but landing on it could have convinced us to the contrary had not its appearance been so satisfactorily explained, and moreover, on more careful observation, a slight rolling motion was still perceptible." This proves that Antarctic bergs may in this way lift a considerable amount of rocky material from the sea-floor, and there is every reason to infer that it might be transported to some distance before being dropped back again, when the iceberg melts. Such phenomena are, however, probably rather exceptional. He states (*op. cit.*, pp. 199-200) that sand and broken shells formed the sea-floor in lat. 73° 3′ S. in 180 fathoms, 120 miles from land, and near the same spot in 230 fathoms "small stones with some pieces of coral and a crustaceous animal (*Nymphon gracile*), common in the Arctic Seas, came up with the lead. * * * We considered it a curious circumstance finding the water so shallow at so great a distance from such high land." The probable explanation of the above, as it seems to me, is that the sea-floor has been reduced to a tolerably uniform level by the deposits formed by the icebergs. It is a significant fact that the water was just deep enough to float the icebergs of that locality. The bergs in their movement equatorwards would tend to keep the deposits on the floor of the ocean skimmed down to about the maximum depth of the flotation of their bases for some distance north of the ice barrier.

Nine days before discovering Mounts Erebus and Terror, when in lat. S. 72° 31′, long. E. 173° 39′, Ross states (*op. cit.*, p. 201)—"The dredge was put over in 270 fathoms water, and after trailing along the ground for some time was hauled in. It was found to contain a block of grey granite, composed of large crystals of quartz, mica, and felspar, with apparently a clean and recent fracture as if lately broken off from the main rock, and had probably been deposited by the agency of an iceberg. Besides this there were a great many stones of various kinds of granite rock." He also states (*op. cit.*, p. 202)—"Corallines, *Flustræ*, and a variety of marine invertebrate animals also came up in the net, showing an abundance and great variety of animal life." Unfortunately Sir James Ross did not note whether the fragments of rock brought up by the dredge were glaciated. Important evidence, however, on this question was obtained later by the "Challenger," as will be stated presently. The organisms obtained from 270 fathoms in lat. S. 72° 31′, long. E. 173° 39′, were as follows (*op. cit.*, App. iv., pp. 334-36) :—Three species of *Lepralia*; *Retepora cellulosa*; a *Retepora* or *Hornera*; a few species of *Primnoa*, *P. Rossii*; a *Melitœa*, nov. sp. *M. australis*; a *Madrepora* (?), nov. sp. *M. fissurata*. In high Antarctic latitudes Ross found that the floor of the ocean was chiefly composed of soft, green mud. Several bergs were seen carrying on their surface large blocks of volcanic rock.

The following statement from the report of the "Challenger" Expedition* is of special interest:—

"From the depth of 1,675 fathoms, in lat. 65° 42′ S., long. 79° 3′ E., the dredge brought up many kinds of rocks and pebbles, some of

* Report of the Scientific Results of the Exploring Voyage of H.M.S. "Challenger," 1873-76. Narrative of the Cruise. Vol. i., p. 434-435.

them showing distinct marks of glaciation, and many of them having a coating of peroxide of manganese on that part which had projected above the mud when lying at the bottom. The rocks belonged to the following lithological types:—Granitites, quartziferous diorites, schistoid diorites, amphibolites, mica-schists, grained quartzites, and partially decomposed earthy shales.

"From the foregoing description it appears that the deposits forming at the most southerly points reached by the 'Challenger' are composed chiefly of continental *débris* carried into the ocean by the floating ice of those regions, and that this material makes up less and less of the deposit as the distance from the Antarctic Circle increases until it completely vanishes about lat. 46° or 47° S. The deposits along the Antarctic Ice Barrier, which have been called blue muds, resemble in many respects the deposits formed at similar depths off the Atlantic coast of British North America. The nature of the rock fragments dredged in these latitudes conclusively proves the existence of continental land, probably of considerable extent within the Antarctic Circle. One of the fragments of gneiss dredged from a depth of 1,950 fathoms measured 50 by 40 centimetres, and weighed more than 20 kilogrammes."

This evidence proves that boulder-bearing clays and sands are at present being deposited on the ocean floor by the agency of icebergs, probably at least as far equatorwards as lat. 46° S., over an area probably at least as large as that of Africa. By a change of ocean currents erratics might be carried on icebergs under present climatic conditions anywhere in the southern hemisphere where icebergs could float, to within 38°, or possibly even 35°, S. lat. Whereas, however, south of lat. 46° S. the glacial deposits probably predominate over the radiolarian and diatomaceous earths, &c., north of that latitude to 35° S. true pelagic deposits, such as red clays and foraminiferal ooze, would probably predominate over the glacial.

(5.) Summary of Evidence.

(1.) If possible traces of ice-action in the Siluro-Devonian conglomerates of Temora, in New South Wales, be omitted, there still remains conclusive evidence to show that there have been *at least two distinct periods when ice was much in evidence in Australia and Tasmania.* The *first* period commenced in Permo-Carboniferous time, and was perhaps prolonged into Triassic time; the *second* was Pliocene or Post-Pliocene.

(2.) By far the most extensive traces of glaciation in Australia and Tasmania belong to the first of these two periods—the Permo-Carboniferous. The chief localities where it is known to be developed, and the nature of the evidence, are as follow:—

(A) *First Glaciation in Permo-Carboniferous or Triassic Time.*

Tasmania.—(*a.*) Near Zeehan. Lat. 41° 50′ S., long. 195° 20′ E. Glacial conglomerate, containing well-rounded beautifully striated pebbles and boulders of rock foreign to the district; is of no great thickness; rests on Devonian sandstone; height above sea-level, 3,000 feet.

(*b.*) Erratics at One Tree Point, Bruni Island, occurring in Marine Permo-Carboniferous strata at or about sea-level. *Gangamopteris spathulata*, McCoy, occurs on the same horizon.

(*c*.) Erratics, some exceeding a ton in weight, in similar strata at Maria Island, Tasmania.

(*d*.) South-west slope of Mount Tyndall. Glacial conglomerate, containing deeply scored and beautifully polished pebbles. Permo-Carboniferous fossils are stated to be associated with them. Height above sea, 3,500 feet.

VICTORIA.—(*e*.) Bacchus Marsh. Lat. 37° 37′ S., long. 144° 20′ E. Boulder-bearing mudstones, the included boulders strongly striated and deeply grooved; conglomerates showing evidence of having been squeezed down in pockets into the mudstones below; sandstones often finely laminated and contemporaneously contorted. The sandstones near the highest observable beds in the series contain *Gangamopteris angustifolius*, *G. obliqua*, *G. spathulata*, and on a still higher horizon fragments of plants like *Schizoneura*. *Zeugophyllites*, &c. Total thickness of series, 3,500 to perhaps 5,000 feet. These are capped unconformably by Eocene strata, and rest with strong unconformity on a powerfully grooved and striated pavement of Ordovician rocks. The pavement is traversed by troughs 500 feet to 600 feet deep; the bottoms of the troughs, their sides, and even the tops of the intervening ridges showing the clearest evidence of having been heavily glaciated, some of the furrows being fully 4 inches deep. The bulk of the groundmass of the boulder-beds and many of the boulders are of local origin, though numbers of the latter, especially the larger erratics, are foreign to the district. The ice which produced the glaciation came from the south, and moved in a direction varying from due north to north-east. Height above sea-level of glacial beds varies from about 600 feet to about 1,400 feet, and that of the glaciated pavement from about 600 feet to 1,200 feet. The glacial beds exhibit well-marked stratification to within 10 feet or 15 feet of the bottoms of the large troughs, and the individual strata of the glacial series run out against the steeply-rising slopes of the glaciated pavements of Ordovician rock.

(*f*.) Wild Duck Creek, near Derrinal, between Heathcote and Sandhurst. Lat. 36° 50′ S., long. 144° 35′ E. Mudstones with beautifully glaciated and polished boulders and large erratics, up to thirty tons in weight, overlie an abraded, grooved, and polished pavement of Ordovician rock. The grooving of the pavement and of the erratics appears to indicate that here also the ice moved from south northwards, the trend of the grooves being towards N. 5° W. If this view be correct, the ice which produced this glaciation must have crossed the Main Dividing Range, which now separates Wild Duck Creek from Bacchus Marsh.

Thickness of glacial beds, together with interstratified sandstone, 50 to 60 feet thick, about 400 feet. Height above sea-level ranges from about 300 to 700 feet. There can be very little doubt as to the Wild Duck Creek glaciation having been contemporaneous with that of Bacchus Marsh.

(*g*.) Beechworth. Lat. 36° 3′ S., long. 146° 7′ E. Glacial beds similar to those of Wild Duck Creek and Bacchus Marsh. This is the furthest point north to which *undoubted* evidence of glaciation in Australia, in Permo-Carboniferous (?) time, has as yet been traced. Height above sea-level, about 500 feet.

SOUTH AUSTRALIA.—(*h.*) Hallett's Cove, near Adelaide. Lat. 35° 6′ S., long. 138° 30′ E. Glacial beds well stratified, and even finely laminated, with strongly striated boulders and erratics, the largest over eight tons in weight; groundmass, composed largely of local rocks floured down or pulverised, and containing abundant intensely worn sand grains like those of sea sand. Thickness at least 100 feet. Beds rest on a glaciated pavement of Pre-Cambrian rock, on which the striæ and furrows are exquisitely preserved. Trend of furrows nearly north and south, changing in places to S.E. and N.W. Some of the large granite erratics have probably come about seventy miles from the south. Their carry, and the glaciation of the pavement, show that the ice came from the south. The glacial beds are capped by marine Miocene strata, showing evidence of erosion along the junction line. In places these glacial beds resemble lithologically those of Bacchus Marsh, and are probably to be correlated with them. It is, of course, possible that they may belong to any age intermediate between that of Miocene and Carboniferous. The beds extend to over 100 feet above sea-level and descend below the level of low tide.

(*i.*) Gorge of the Torrens, near Adelaide. Lat. 34° 45′ S., long. 138° 50′ E.

(*j.*) Curramulka, Yorke's Peninsula. Lat. 34° 40′ S., long. 137° 40′ E. Glaciated pavement of Pre-Cambrian or Cambrian rock, the grooves running north and south. Boulders of granite, possibly erratics, also present. This glaciation is obviously to be correlated with that of Hallett's Cove, on the opposite side of St. Vincent's Gulf.

(*k.*) Valley of the Inman River, near Port Victor. A smooth striated and grooved rock surface, with boulder-beds. Direction of grooves, east and west. Their *stoss-seite* not yet determined. Height above sea inconsiderable.

NEW SOUTH WALES.—(*l.*) Marangaroo. Marine Permo-Carboniferous conglomerate, with large blocks of rock, possibly erratics, the largest about 4 feet in diameter. Lat. 33° 17′ S., long. 150° 10′ E. Height above sea, 2,700 to 3,100 feet.

(*m.*) Maitland, Hunter River Valley. Lat. 32° 45′ S., long. 151° 35′ E. Erratics of granite and Devonian quartzites and grits, the Devonian rocks having travelled, probably from parent rock, about sixty miles to the south-west, from the neighbourhood of Wallerawang or Bathurst. Largest erratics, about 5 feet in diameter. Some show faint striæ and slight appearance of faceting, but no markings which could be described as undoubtedly glacial have as yet been observed. They occur in the Permo-Carboniferous strata of both the Upper Marine Series and the Lower Marine Series, but chiefly in the Upper Marine, these two horizons being separated from one another by the Greta Coal Measures. At present they extend from about 100 feet above sea-level to probably at least 6,000 feet below sea-level in the neighbourhood of Sydney.

(*n.*) Branxton, Hunter River Valley. Lat. 32° 40′ S., long. 151° 20′ E. Erratics similar to those of Maitland. Faint striæ observable on some, but not of undoubted glacial origin. Greatest diameter, from 3 to 4 feet. Evidence very clear that the erratics were dropped from some height, as they have indented the rocks below them—in one case, at all events, to the depth of 6 inches, perhaps more. Height above sea, 100 to about 200 feet.

(*o.*) Grasstree, near Muswellbrook. Lat. 32° 20′ S., long. 150° 59′ E. Erratics similar to those of Branxton and Maitland. Geological horizon is that of the Upper Marine Series of the Permo-Carboniferous System. Height above sea, about 170 to 200 feet.

QUEENSLAND.—(*p.*) Bowen River Coal Field. Lat. 23° S., long. 149° E. Erratics, the largest of about the capacity of 2 cubic feet, and mostly angular or subangular. They occur chiefly in the Marine Permo-Carboniferous beds of the Middle Bowen Series, and the horizon is probably homotaxial with that of the Upper Marine Series of New South Wales.

Possible Evidences of Glaciation in Triassic Time.

NEW SOUTH WALES.—(*a.*) Disrupted and bent masses of clay shale, and contemporaneously contorted bedding in the Hawkesbury Series near Sydney. Lat. 33° 52′ S., long. 151° 12′ E. Height above sea, twenty to forty feet.

(*b.*) Disrupted fragments of clay shale in Hawkesbury Sandstone near Katoomba. Lat. 33° 45′ S., long. 150° 28′ E. Height above sea, about 3,350 feet.

Second Glaciation of Australia and Tasmania in Pliocene or in Post-Pliocene Time.

TASMANIA.—(*a.*) Planed and grooved rock surfaces, terminal moraines, and erratics near Lake Dora. Lat. 41° 52′ S., long. 145° 33′ E. *Roches moutonnées* are frequent. Direction of grooving very variable, chiefly towards east and south-east. Some morainic blocks, perhaps over 100 tons in weight, are all of local origin. Well-defined terminal moraines, 150 feet to 250 feet high, prove conclusively that these evidences of ice-action are due to land glaciers only. Lakes and tarns of glacial origin are also numerous. Height above sea-level ranges from 1,750 feet to 3,000 feet. Similar evidences occur a trifle further north at Lake Rolleston and Lake Ruby. In the same district Mount Tyndall is glaciated from 2,182 feet to its summit, 3,850 feet high; and Mount Sedgwick, 4,000 feet high, is also glaciated to within a few feet of its summit.

(*b.*) Valley of the MacIntosh River. Lat. 41° 40′ S., long. 145° 30′ E. Granite erratics at least five tons in weight.

(*c.*) Lake Dixon. *Roches moutonnées*, moraines, and large erratics. Elevation about 2,000 feet.

(*d.*) Mount Pelion, Barn Bluff, and the head of the Forth. Lat. 41° 45′ S., long. 146° E. *Roches moutonnées*, erratics, and striated rock surfaces. Movement of ice, near East Mount Pelion, from north to south. Traces of glaciation so fresh that Mr. Montgomery thinks they cannot be older than Pleistocene. Moraines, erratics, and *roches moutonnées* also in same neighbourhood, near Lake Eyre. Height above sea of last-mentioned ranges from 2,000 to 2,792 feet.

(*e.*) Scott's Peak, in the Arthur Ranges. Moraines, *roches moutonnées*, and polished rock surfaces.

VICTORIA.—(*f.*) Mount Bogong District. Lat. 36° 42′ S., long. 147° 10′ E. Reewa Valley. Moraines (?) at 1,000 feet above sea-level.

(*g.*) Mountain Valley Creek, northern base of Mount Bogong. Lat. 36° 45′ S., long. 147° 20′ E. Large angular masses of rock, perhaps redistributed moraines. Height above sea, 2,000 feet.

(*h.*) Glaciated (?) surfaces on the Cobboras, extending between levels of 4,000 and 6,000 feet above the sea.

(*i.*) Glaciated (?) surface on Mount Pilot, extending down to 3,000 feet above the sea.

(*j.*) Glaciated (?) surface on Mount Bogong.

(*k.*) Eroded lake basins, Dry Hill, Hermomugee Swamp, and Omeo Lake Basin; Morainic (?) Lake, Mount Wellington.

New South Wales.—(*l.*) Kosciusko. Lat. 36° 40′ S., long. about 148° E. Abraded rock surfaces and *roches moutonnées* at Tom's Flat and in the Wilkinson Valley, showing it to have been probably filled with ice to a depth of 500 feet. Morainic material and undoubted ice-scratched blocks between Mount Kosciusko, Mount Twynam, and Boggy Plain. The glaciers and snowfields here had an area of perhaps 150 square miles. Height above sea ranges from about 5,200 to about 7,351 feet, if it be assumed that the glaciation extended to the summit of the highest peak, Mount Townsend.

(6.) Conclusions.

The following provisional conclusions are suggested:—

(1.) That Australia and Tasmania have passed through at least two important periods of glaciation. The first, and far the severer, may have commenced in Gympie time (Carboniferous), or, at any rate, in some portion of the Permo-Carboniferous period, and may have continued, with possible interglacial epochs, to perhaps some part of the Triassic period. The later glaciation, according to the opinion of most observers, was probably Post-Pliocene.

(2.) That the glacial beds of Bacchus Marsh, Wild Duck Creek, and Beechworth, in Victoria, are almost undoubtedly homotaxial with one another, and perhaps homotaxial with the glacial beds of Hallett's Cove, in South Australia, and with the older glacial conglomerates of Mount Reid and Mount Tyndall, in Tasmania; and perhaps with the mudstones containing erratics of Maria Island, and One-Tree Point, Bruni, in Tasmania; with the similar beds at Maitland, Branxton, and Grasstree, in New South Wales; and with those of the Bowen River Coal Field, in Queensland.

Direction of Movement of Permo-Carboniferous Ice.

(3.) In Australia, Southern Africa, and India the Permo-Carboniferous ice has in most cases moved from a southerly towards a northerly direction, as proved by the grooved rock surfaces as well as by the carry of the erratics. At Hallett's Cove the movement has been towards N. or N.W., chiefly N., and at Curramulka, northerly, but at the Inman Valley E. and W. At Bacchus Marsh towards N. or N.N.E. At Wild Duck Creek, N. Between Wallerawang and Maitland, towards N.E.

(4.) As regards *the source of the erratics* in the Australian and Tasmanian Permo-Carboniferous (?) glacial beds, while many are of local origin, some are foreign, the latter being the case especially with regard to those in Victoria, which may have been derived (*a*) from Tasmania or (*b*) from land, since denuded, lying to the west of Tasmania; (*c*) from New Zealand, but no erratics of the peculiar granite which has supplied the granite blocks found in Preservation Inlet in New

Zealand, as described by Captain Hutton, have as yet been identified in the Permo-Carboniferous glacial beds of Australia or Tasmania; (*d*) from Terre Adélie, or some other land in the Antarctic regions. That granitic and various crystalline rocks somewhat similar to those found in the glacial beds of Victoria and Tasmania exist in Antarctic regions was ascertained by the great French Expedition in the corvettes "Astrolabe" and "Zéleé."*

(5.) It is stated that (*op. cit.*, vol. xxii., p. 47) "at Adélie Land we obtained numerous specimens of granite passing into gneiss." These specimens are described (*op. cit.*, vol. xxiii., p. 214) as follows:—"No. 177, Reddish coarse-grained gneiss, with red felspar and brown mica. No. 17, Granulitic ('*leptinöide*') fine-grained, almost compact gneiss, of greenish-grey colour with bronze-coloured mica." The general height of this land was estimated as 1,300 feet. It is also stated (*op. cit.*, vol. xxii., p. 47) that M. Dubouzet discovered débris of granite in the stomach of a penguin. Dr. McCormack, in the "Erebus," also frequently found fragments of granite in the crops of penguins, and reference has already been made to Sir James Ross dredging a fragment of coarse-grained granite off the coast of Victoria Land, and to the "Challenger" dredging fragments of granitites, diorites, amphibolites, mica-schists, quartzites, and clay shales from near the so-called Termination Land of Wilkes. In the South Orkneys there are high mountains, the bases of which were found by the "Astrolabe" and "Zéleé" Expedition to be composed of a greyish-white limestone, and schists like phyllites (*op. cit.*, vol. xxii., p. 32). In the South Shetlands, Lieut. Kendal, of the "Chanticleer," found the land to be composed of "a collection of needle-like pinnacles of syenite, covered with snow." (A quotation, *op. cit.*, vol. xxii., p. 38.) It is also stated a little further on that Smith, Livingston, Greenwich, Roberts, King George, and Elephant Islands are composed of a primary schistose formation, traversed by intrusions of igneous rocks, syenite, porphyry, &c., and probably also by very modern dykes of volcanic rocks, while Powell Islands are composed of phyllite-like talc rocks and quartzose talc rocks, and (*op. cit.*, p. 42) it is also stated that the rocks which compose the New South Orkney Islands of granite and syenite form the greater part of the erratics observed on the coast of Terra del Fuego. As, therefore, there is a considerable area of high land in Antarctic regions composed of granitic and schistose rocks, which probably has supplied erratics to Terra del Fuego in perhaps Pliocene or Post-Pliocene time, it is not unreasonable to suppose that some land in the direction of the Antarctic regions, but not necessarily, of course, coterminous with any modern Antarctic land, may have supplied erratics for transport to Australia in Permo-Carboniferous time.

(6.) *Proximity of Land.*—That land could not have been very far distant in Victoria during the Permo-Carboniferous glaciation is proved (*a*) by the numerous and thick layers of conglomerate, associated with the boulder beds; and (*b*) by the abundance of *Gangamopteris* leaves on at least one horizon in the glacial beds. The association of *Gangamopteris* with the erratic-bearing Permo-Carboniferous mudstones of Tasmania point to a similar conclusion.

* Voyage au Pole Sud et dans l'Océanie, sur les corvettes "L'Astrolabe" et "La Zéleé." Exécuté pendant les années, 1837-1840. Sous le commandement de M. J. Dumont—D'Urville, vols. xxii-xxiii, Paris, 1848.

(7.) The *biological evidence* points to the probability of a general refrigeration of the land and sea in Permo-Carboniferous time, as suggested by (*a*) the great break between the floras of the Carboniferous and Permo-Carboniferous periods in Australia; (*b*) the entire absence of beds of pure limestone from the marine beds of the Permo-Carboniferous strata south of lat. 31° S.

(8.) *Nature of the Permo-Carboniferous Glaciation.*—As regards the question as to whether all the glacial phenomena in the Permo-Carboniferous rocks are referable to (*a*) floating ice alone; (*b*) to land ice alone; or (*c*) to the combined action of land ice and floating ice, the (*a*) and (*c*) hypotheses will be discussed first, and (*b*) last. As regards (*a*) the following arguments may be adduced in favour of all the glacial phenomena being referable to floating ice alone:—

(i.) Although the grooves are deeply cut in places in the pavement at Bacchus Marsh, there is a slight want of uniformity in their trend, some sets of grooves crossing others so as to enclose a small angle at their intersection. It also appeared to me that the grooves were not quite so firmly nor sharply cut as those made by some land glaciers.

(ii.) No evidence has as yet been observed of any true moraines, either terminal, medial, or lateral.

(iii.) All the included boulders observed by me were either rounded or subangular, whereas angular fragments would, perhaps, have been plentiful if the material had been deposited by land ice.

(iv.) While the groundmass of the rock is largely of local origin, many of the erratics are quite foreign to the district, whereas had they been brought by land ice the large boulders would have been of local origin, unless the glaciers were over 100 miles or so in length.

(v.) The perfect stratification of the glacial beds implies aqueous deposition. This is most noticeable at Hallett's Cove, where the glaciated surface of Pre-Cambrian rock is immediately capped by finely laminated sandy shales belonging to the glacial beds. The tough mudstones containing the boulders are not distinctly stratified in places, but occur in well-marked beds, from 10 to about 30 feet thick, with great regularity, being separated from one another by widely distributed beds of conglomerate and fine sandstone.

(vi.) The intensely worn characters of the sand grains in the groundmass of the boulder beds at Hallett's Cove is very suggestive of the sands being of marine origin.

(vii.) The indenting of the beds on which the large erratics repose is proof of the latter having been dropped from some height, and having fallen, probably through water, until they struck the bottom.

(viii.) The manner in which the conglomerates have been squeezed down in the form of pockets, in places, into the boulder beds is suggestive of the action of floating ice, but might, of course, have been accomplished by land ice.

(ix.) During the great submergence which affected a large portion of East Australia and Tasmania, in Permo-Carboniferous time, the area now occupied by the glaciated pavements would also probably have been submerged. It is singular that in Australia, South Africa, and India the pavements are less than 1,000 feet above the sea, and at

Hallett's Cove the pavement probably extends for below sea-level. This, of course, may be only a coincidence, as great changes of level may have taken place since Permo-Carboniferous time, and the low elevation of the glaciated pavements may be due to the fact that only such low-lying areas would be likely to escape destruction by denudation.

(x.) Observations made during the "Challenger" and "Erebus" and "Terror" expeditions to the Antarctic regions show that a boulder-bearing clay, soft mud, and sand is at the present moment being laid down over a large area of the ocean floor, which, if it be nearly co-extensive with the area over which icebergs constantly drift, may possibly be equal to that of the continent of Africa. These deposits, if consolidated, would perhaps somewhat resemble the Bacchus Marsh glacial deposits; but it is very doubtful whether they would contain the persistent beds of conglomerate characteristic of the latter locality; and they certainly would contain a more or less abundant protozoan fauna, which, as far as at present known, the glacial beds of Bacchus Marsh and Hallett's Cove do not.

As arguments against the hypothesis that all the Permo-Carboniferous glacial phenomena were produced by drift ice alone, the following might be adduced:—

(i.) No marine fossils, macroscopic or microscopic, have as yet been detected in the boulder beds proper, or in the associated sandstones and conglomerates. Marine fossils have as yet been found only in the Permo-Carboniferous mudstones which contain the erratics.

(ii.) Land, or lacustrine, or swamp plants, such as *Gangamopteris*, are associated with the glacial beds, and small fragments of plants are distributed through the groundmass of the boulder beds.

(iii.) The glaciation of every nook and corner of the pavement, even where its surface is extremely uneven, is suggestive of the searching action of land ice.

(iv.) The local character of the material composing the groundmass, a feature specially noticeable at Hallett's Cove, is rather in favour of its having been produced by land ice.

(v.) Erratics, now found at Maitland, and derived probably from Mount Lambie, almost necessarily demand carriage by land ice, or by an ice foot. The chances of the erratics having fallen from high cliffs, with water sufficiently deep at their bases to float bergs of any thickness, and of their having then been transported by bergs to Maitland, seem rather small.

As regards (*b*) the possibility of all the Permo-Carboniferous glacial phenomena being referable to the action of land ice alone, it appears to me that in view of the close resemblance of these glacial deposits of Australia to the far newer Pleistocene evidences of glaciation in Europe and America, and in view of the now generally received opinion that the latter are chiefly attributable to land ice, it is not improbable that this explanation will serve also for the former. The stratification of the conglomerates and lamination of the sandstones and mudstones may have been the work of sub-glacial streams and sub-glacial lakes. Unfortunately a copy of the new edition of Professor James Geikie's Great Ice Age, &c., has not yet reached me, so that I am unable to quote from the information which he has gathered on this part of the subject. I should like, however, to quote from an earlier publication of that accomplished glacialist, as it seems to me that what he says has happened in the evolution of scientific thought on the subject of the glaciations of Europe and America may come to pass in our time in Australasia.

Professor James Geikie, in his address to the Geological Section of the British Association, at Birmingham, 12th Sept., 1889,* stated that—

"At first icebergs are appealed to as explaining everything. Next we meet with sundry ingenious attempts at a compromise between floating ice and a continuous ice-sheet. As observations multiply, however, the element of floating ice is gradually eliminated, and all the phenomena are explained by means of land ice and 'schmelzwasser' alone."

Speaking of the evidences of glaciation in Germany, he says (*op. cit.*, p. 464)—"Nowhere do German geologists find any evidence of marine action. On the contrary, the dovetailing and interosculation of boulder-clay with aqueous deposits are explained by the relation of the ice to the surface over which it flowed. Throughout the peripheral area it did not rest so continuously upon the ground as was the case in the inner region of glacial erosion. In many places it was tunnelled by rapid streams and rivers, and here and there it arched over sub-glacial lakes, so that accumulation of ground moraine proceeded side by side with the formation of aqueous sediments."

With regard to the absence, as far as yet known, of a distinct terminal moraine in Victoria, Professor Geikie's statement with regard to the Pleistocene glaciation of Germany might also apply to that of Victoria in Permo-Carboniferous times. His words are (*op. cit.*, p. 465)—"When the inland ice flowed south to the Hartz and the hills of Saxony, it formed no great terminal moraines. Doubtless, many erratics and much rock-rubbish were showered upon the surface of the ice from the higher mountains of Scandinavia, but owing to fanning out of the ice on its southward march such superficial débris was necessarily spread over a constantly widening area. It may well be doubted, therefore, whether it even reached the terminal front of the ice-sheet in sufficient bulk to form conspicuous moraines. It seems most probable that the terminal moraines of the great inland ice would consist of low banks of boulder-clay and aqueous materials—the latter, perhaps, strongly predominating, and containing here and there larger and smaller angular erratics which had travelled on the surface of the ice."

The occurrence of the erratics in the marine Permo-Carboniferous strata must of course in any case be referred to the action of floating ice. The following is an account of how such erratics were dropped into marine clays in Post-Tertiary geological time:—

Professor Stone† states that—

"The clays and sands that were formed off the shore of the sea in Maine during the 'Champlain' elevation of the sea are strewn with erratic boulders up to 20 feet in diameter. The clays are fossiliferous and must have been formed in the open sea. The boulders were dropped

* Geol. Mag., new series, Dec., iii., vol 6, 1889, p. 461.
† Geol. Mag., new series, Dec., iii., vol. 6., 1889, p. 425.

from floes of shore-ice or small bergs. Every winter the shore-ice became attached to boulders, and in the spring these boulders are carried out to sea and along the coast, when the ice becomes detached from the shore."

(9.) *Duration of the Permo-Carboniferous Glacial Period.*—That glacial conditions prevailed throughout a long period of geological time, about the close of the Palæozoic Era, is proved by (*a*) the great thickness (at least 3,500 feet) of the glacial beds at Bacchus Marsh; (*b*) the great number of boulder bed horizons (probably at least twenty, but this is only a very rough estimate by me) in the same glacial series, each boulder bed separated from the one above and below it by strata of conglomerate and sandstone; (*c*) in New South Wales glacial conditions obtained while (i) several hundred feet of sandstones and mudstones of the Lower Marine Series of the Permo-Carboniferous System were being deposited, (ii) while, after an interval sufficient to allow of the formation of 50 feet of coal, in the succeeding Permo-Carboniferous Greta Coal Measures (for the sake of argument, 50,000 years), the last 1,000 feet of the lower 2,000 feet of the Upper Marine Series were being formed.

If glacial conditions continued in Australia down to Triassic time, as the evidence quoted already from the Hawkesbury Series renders not improbable, further time must be allowed for the great biological break in the fauna and flora, which in Australia separates the Permo-Carboniferous from the Triassic period.

(10.) *Pliocene or Pleistocene Glaciation the Work of Land Ice.*—That during Pliocene or Pleistocene time the Australian Alps harboured glaciers, which descended at Kosciusko to within about 5,200 feet above the sea, on the assumption that the earth's crust at Kosciusko has been practically stationary from the last epoch of glaciation down to the present time. That in Victoria, near Mount Bogong, at Mountain Creek Valley, morainic (?) material extends down to a level of 2,000 feet above the sea, and possibly only 1,000 feet in the Reewa Valley. Synchronously, the Western Highlands of Tasmania, from an elevation of 4,000 feet or 5,000 feet down to about 2,000 feet, were covered with snowfields and glaciers. This glaciation of South-eastern Australia and Tasmania was effected entirely by land ice.

(11.) *That there is as yet insufficient biological evidence to prove a refrigeration of the sea during the above glacier epoch.* The abundance of *Mytilus minkeanus* in the raised beaches of Maitland, in New South Wales, and its large size, has been suggested as in favour of there having been a cooling of the waters of the South Pacific; but I am informed by Messrs. G. B. Pritchard and T. S. Hall that the above species ranges as far north as Port Adelaide Creek, near Adelaide, in St. Vincent's Gulf, and specimens as large as those of the Maitland raised beaches are met with, as stated by the above observers, on the South Australian coast.

The occurrence of *Siphonalia maxima* in the Pleistocene delta deposits of the Hunter River, near Newcastle, in New South Wales, can likewise be explained away without perhaps necessitating a cooling of the sea water. Messrs. Hall and Pritchard inform me that *S. maxima* (*S. tasmaniensis*) occurs along the Victorian coast, and that of South Australia as far north as the latitude of Adelaide, 34° 9′ S., which is only two degrees south of the latitude of Newcastle, in New South Wales.

More satisfactory biological evidence on this subject is much needed.

(12.) Evidence is as yet insufficient to show whether or not the Pliocene or Pleistocene glaciation of Australia and Tasmania was synchronous with the former great extension of the glaciers of New Zealand, and the late Tertiary or Post-Tertiary glaciation of Kerguelen Island and of southern South America.*

The temptation to indulge in theories as to the causes of the glaciations in the southern hemisphere, in Permo-Carboniferous and in Cainozoic time, are very strong; but it would perhaps be better for us Australian geologists to sail by these rocks of the Sirens, stopping our ears lest we be lured to our doom. The spirit which animated the founders of the Geological Society of London should move us all to observe more and to theorise less. A fair field of research lies before us in Australasia, which for the magnitude of its area glaciated in Palæozoic time, the clearness and intensity of this Palæozoic glaciation, and the thickness and extent of its Palæozoic glacial beds stands as yet without a rival in any part of the world. Let anyone who questions the accuracy of this statement follow the advice of that grand old geologist Desmarest, and "Go and see"; and he will be made of very unsentimental stuff indeed if he does not thrill with enthusiasm at the sight of those stately ruins, silent yet speaking eloquently of a bygone time when thick blue ice invaded our southern shores and marched, irresistible, over our mountains.

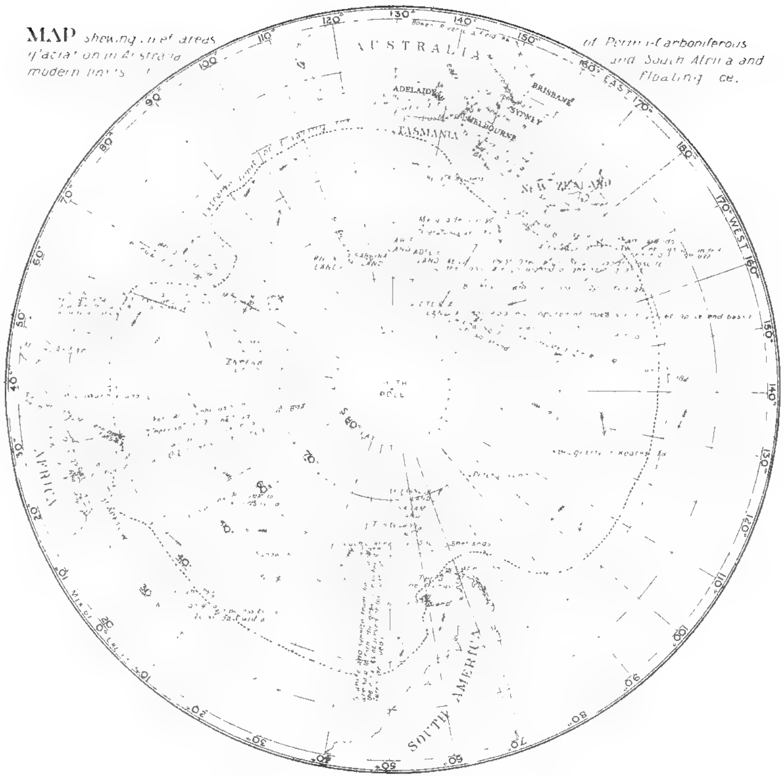
To summarise the work that has been done in Australia and Tasmania on this great ice question in such a form as to prove of some use, I trust, to future workers has been my chief end in preparing this address; and most sincerely do I hope that, chilly as the subject is, it will never lead to a coolness springing up between any two of our geological workers. For my own part I have received such universal kindness and assistance, when preparing material for this address, that I feel more than ever convinced of the strength and permanence of that feeling of federation and brotherhood among Australian geological workers, which is the outcome of unselfishness, and which gives bright promise of our winning, in the near future, by our united efforts, fresh victories for the great cause of Truth.

My thanks are specially due, for much kind help rendered me while preparing this address, to the following:—Mr. Charles C. Brittlebank; Mr. George Sweet, F.G.S.; Professor Tate; Mr. Walter Howchin, F.G.S.; Mr. L. Birks; Mr. A. W. Howitt, F.G.S.; Mr. E. F. Pittman, Assoc. R.S.M.; Mr. R. Etheridge, junr.; Mr. W. S. Dun; Mr. R. L. Jack, F.G.S.; Mr. A. G. Maitland; Mr. C. W. de Vis, M.A.; Mr. T. S. Hall, M.A.; and Mr. G. B. Pritchard.

NOTE.—Since the above address was delivered, additional evidence of the presence of granite and other crystalline rocks in the Antarctic regions has been furnished by Mr. Borchgrevinck, of the whaler "Antarctic." He collected, at the beginning of this year, at Cape Adair, in Victoria Land, specimens of rocks which I have identified as microcline granites, containing garnet and tourmaline, and mica-schists.

* For references to the last-mentioned, see Geology, vol. ii., Stratigraphical, by Professor Prestwich, p. 466.

MAP shewing [illegible] areas [illegible] of Permo-Carboniferous glaciation in Australia and South Africa and modern limits [illegible] floating ice.



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MAP shewing position of glaciated areas, and of erratics in Australia and Tasmania

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Section D.

BIOLOGY.

ADDRESS BY THE PRESIDENT,

PROFESSOR ARTHUR DENDY, D.Sc.

THE CRYPTOZOIC FAUNA OF AUSTRALASIA.

The subject upon which I have the honour to address you to-day is one in which I have personally been deeply interested ever since my first arrival in Australia seven years ago, and in the knowledge of which a considerable amount of progress has been made of late years by many Australasian naturalists. It would, however, be impossible for any one zoologist to give a complete account of our cryptozoic fauna, partly owing to the fact that much work still remains to be accomplished in the field, and partly because in these days of specialisation no one man could presume to deal competently with so many different branches of zoology as are involved. If, therefore, I seem to lay undue stress upon those parts of the subject which I have personally investigated, and to give less than its due share of attention to the work of others, I hope it will not be thought that I am wanting in respect for other observers. Such is far from being the case, and I hope that the many omissions which this address must needs contain will be put down to the superficial nature of my knowledge of those groups of animals which I have not myself studied in detail.

I must also apologise for making such free use of a term coined by myself, and hardly perhaps as yet in general circulation amongst biologists. I can only plead that I use the word "Cryptozoic" for want of a better. Five years ago it appeared to me that the assemblage of small terrestrial animals found dwelling in darkness beneath stones, rotten logs, and the bark of trees, and in other similar situations, was well deserving of study in its entirety, and that it constituted a section of the terrestrial fauna quite as distinct from the remainder as, for example, the littoral or abyssal fauna is from the remainder of the marine fauna.

Of course no fauna can be sharply defined from those which verge upon it. The littoral fauna passes gradually into that of the deep sea on the one hand, and that of the open ocean on the other. So it is also with the cryptozoic fauna, which passes, on the one hand, into the burrowing fauna, composed of animals which burrow for themselves beneath the surface of the earth, and on the other into the vast assemblage of animals which live in open daylight.

The members of the cryptozoic fauna have been derived from nearly all the principal groups of the animal kingdom, and the only character which they all possess in common is their hatred of exposure. The darkness or semi-darkness in which they live, however, does not seem to have had any influence upon the eyes of cryptozoic animals. In this respect they differ markedly from many animals which dwell in dark places—such as the inhabitants of caves, some burrowing animals, some deep-sea forms, and the remarkable blind crustacea found inhabiting the subterranean waters of New Zealand, and so admirably described by Dr. Chilton.* The cryptozoic animals appear to avoid the light by choice and of their own free will, and there can be no doubt that their eyes are of actual service to them in distinguishing between light and dark places, and in perceiving when it is dark enough for them to safely venture forth from their hiding-places in search of food. One of the most striking and often annoying facts which confronts the field naturalist in search of cryptozoic animals is the rapidity with which many of them disappear again into dark crevices as soon as their cover is removed.

Some forms evidently prefer one kind of cryptozoic haunt to another. In the South Island of New Zealand, for example, I have found numerous specimens of a large *Chelifer* beneath stones, while I never observed them under fallen logs, which were abundant in the immediate vicinity. The choice is probably determined in some cases by questions of food supply, and in others by questions of temperature or moisture. Other forms occur apparently indiscriminately under logs or stones, as, for example, the larger Victorian *Peripatus* and the Australian Land Nemertine (*Geonemertes australiensis*), the main objects to be secured being evidently darkness and moisture.

Divers causes have probably impelled different members of the cryptozoic fauna to adopt their peculiar mode of life. A large proportion of them are doubtless to be looked upon as refugees; but, while some seek protection from living enemies and competitors, others do so quite as much on account of their delicate organisation being unable to stand exposure to the light and heat of day. "Drying up" is fatal to many cryptozoic animals, and especially to those which belong to typically aquatic groups, such as the Nemertines and Land Planarians, which, as collectors know to their cost, dry up very rapidly when removed from their native haunts, unless care be taken to supply them with abundant moisture. Nor is moisture alone all that is requisite for their welfare. The question of temperature is likewise of vital importance, at any rate in the case of Land Planarians, which, even when supplied with abundant moisture, rapidly perish and disintegrate into a liquid, evil-smelling mass, unless they be carefully kept cool.

Other cryptozoic animals are doubtless attracted by the presence of some special food supply which flourishes in their dark retreats. Decaying logs, for example, are commonly infested with numerous fungi of many kinds. Mycetozoa, moulds, and more highly organised forms are extremely common. In a damp beech forest of New Zealand I have cut open rotting logs which have been reduced in the interior to a semi-transparent, clear, soft jelly, still showing the grain

* Trans. Linn. Soc., Lond., vol. vi., part 2, 1894.

of the wood. This I attribute to the action probably of some mycetozoon. In other cases the wood is simply mouldy, like old cheese, while in others it supports in its interstices a perfect garden of most exquisite fungi. These fungi doubtless afford a supply of food to many small animals.

The cryptozoic fauna has been recruited not only from many distinct classes of the animal kingdom, but from several distinct faunistic groups, and it appears to me that it may thus be divided into four sections, distinguished by their mode of origin :—

(*a.*) *Representatives of typically terrestrial groups of animals which are dominant at the present day.*—These may be found in all stages of development. This section is much the strongest, both in numbers and variety. It includes, for example, many insects, especially ants, beetles, and cockroaches; many spiders, many centipedes and millipedes, and many slugs and snails. Of course all these, in common with other terrestrial animals, have doubtless been derived in the first instance from aquatic ancestors; but they have become so modified in structure in accordance with their change of habitat and so dominant on the land, as to entitle them to be considered as typically terrestrial.

(*b.*) *Surviving members of extremely ancient groups which are now almost extinct.*—In this section we may perhaps include the scorpions, which are of extreme antiquity, dating back to the Silurian epoch, and which can hardly be considered as a dominant group at the present day. In addition to these I know of only one genus which belongs here, and that of course is the remarkable *Peripatus*, which has attracted so much attention during the last few years, and which is perhaps the most interesting member of the cryptozoic fauna. These primitive types appear to have successfully evaded the struggle for existence by taking refuge in obscure retreats.

(*c.*) *Immature forms of terrestrial animals which are not cryptozoic in the adult condition.*—This section includes the larvæ of various insects of which the adults live in the open.

(*d.*) *Isolated representatives of typically aquatic groups of animals which have as yet become but little modified in accordance with their new mode of life.*—This division is both large and of exceptional interest, for we find in it many animals which are, so to speak, in a transitional condition between aquatic and terrestrial, and we may perhaps gain much information from them as to the manner in which this great transition from an aquatic to a terrestrial mode of life has been effected. Every naturalist knows how many small animals swarm beneath half-dry stones on the sea shore. Such species appear to me to be taking the first step towards a terrestrial life. Gradually they will make their way inland, still keeping beneath logs and stones for the sake of moisture and coolness, until finally they accustom themselves to a thoroughly terrestrial existence.

In this section of the cryptozoic fauna we must place the shrimp-like *Amphipoda* and *Isopoda*, which certainly look strangely out of place on land, together with the remarkable Land Planarians, so abundant and varied in Australasia, and the still more remarkable Land Nemertines.

Having thus endeavoured to give a general idea of the nature and origin of the cryptozoic fauna, I propose, with your permission, to give a short review of our knowledge of the principal groups of cryptozoic animals met with in Australasia, considering them in their proper zoological order.

VERTEBRATA.

It is doubtful whether it would be expedient to consider any vertebrate animals as forming a normal constituent of the cryptozoic fauna, although several small vertebrates are not infrequently found in cryptozoic haunts. Lizards, for example, and small snakes are very commonly met with under logs and stones, but these animals are by no means constrained by their organisation to adopt such a habitat, except in cases of hibernation, and probably merely make use of these retreats as temporary hiding-places. With frogs the case is somewhat different. They cannot withstand drought, and their presence under logs and stones is doubtless usually to be explained by the moisture of these situations. Moreover, it is not improbable that they make use of the rich supply of animal food in such localities; and some species may even pass the greater part of their lives therein. Many, of course, take to the water for breeding purposes, but some may even deposit their spawn under stones and in such like situations. I have observed this fact myself in Victoria, and Mr. Fletcher has published some very interesting notes on the subject, together with many other observations on the habits of Australian Batrachians, in the Proceedings of the Linnean Society of New South Wales. He says,* "The two species of *Pseudophryne* do not deposit in water, but under stones, &c., in damp situations. The tadpoles, though capable of sustaining without injury a prolonged postponement of the hatching—in one case for a period of over three months—seem unable to complete their metamorphoses without gaining access to water." He also quotes from Boulenger the interesting fact that there are certain Batrachians which deposit their ova in damp situations or on leaves, and whose embryos leave the eggs in the perfect air-breathing form.

Those who are interested in the numerous species of Australian frogs should refer to the papers by Mr. Fletcher in the Proceedings of the Linnean Society of New South Wales, and by Mr. Lucas in the Proceedings of the Royal Society of Victoria. In New Zealand only a single species of frog is known to occur—viz., *Leiopelma hochstetteri*—and that is very rare and confined to the district around Auckland, in the North Island.

MOLLUSCA.

Although a large proportion of the species are of very insignificant dimensions, the number of Australasian land snails and slugs is surprisingly large.

All of these are probably more or less cryptozoic in habit, the need for moisture rendering such a mode of life imperative.

Mr. H. Suter has kindly drawn up for me a list of those land mollusca which are found under logs and stones, and decaying leaves,

* Proc. Linn. Soc. N.S.W., vol. iv. [Ser. 2], p. 360.

&c., in New Zealand alone, which serves to give a very fair idea of the extreme richness of our fauna in this group. The list is as follows :—

Lagochilus, 8 species; *Realia*, 4 species; *Hydrocena*, 1 species; *Athoracophorus*, 4 species; *Flammulina*, 13 species; *Gerontia*, 2 species; *Phacussa*, 3 species; *Therasia*, 7 species; *Pyrrha*, 2 species; *Phenacohelix*, 3 species; *Allodiscus*, 12 species; *Suteria*, 1 species; *Thalassohelix*, 5 species; *Endodonta*, 11 species; *Charopa*, 22 species; *Phenacharopa*, 1 species; *Aeschrodomus*, 2 species; *Laoma*, 4 species; *Phrixgnathus*, 21 species; *Otoconcha*, 1 species; *Ariophanta*, 1 species; *Rhytida*, 6 species; *Paryphanta*, 5 species; *Schizoglossa*, 1 species; *Rhenea*, 2 species.

Thus we see that in New Zealand alone there are no less than 142 species of cryptozoic mollusca, and the strangest part of it is that, according to Hedley and Suter,* "the *whole* of the species are now known to be strictly endemic." Surely there must be something about the mollusca which is especially favourable to geographical variation!

The comparative richness of this group in known species may, however, be partly accounted for by the large amount of attention which has been devoted to it, especially of late years. It would be impossible to attempt to give an adequate idea of this work on the present occasion, and I cannot do better than refer the uninitiated to the valuable list of literature given by Messrs. Hedley and Suter* in their "Reference List of the Land and Freshwater Mollusca of New Zealand," which includes the more important publications on the Land and Freshwater Mollusca of all the Australasian colonies.

Where there is so much to choose from it would be difficult, especially for a non-specialist, to select those forms of Australasian Land Mollusca which are most deserving of mention; but there appears to be a general consensus of opinion that, for interest and peculiarity, the bitentaculate slugs of the family Janellidæ take the palm. These remarkable slugs are of large size, and form a conspicuous feature in the cryptozoic fauna, especially of New Zealand. Their most obvious characteristic is the absence of the smaller pair of tentacles met with in other slugs, only the larger eye-bearing pair being present. Two genera are recognised, viz.:—*Athoracophorus* (*Janella*), of New Zealand and the Admiralty Islands; and *Aneitea* (*Triboniophorus*), of Australia, the New Hebrides, and New Caledonia.

The common New Zealand *Athoracophorus* is a large and handsome slug, which I have often taken under dead wood. The animal is of a greyish colour, and the dorsal surface is shaped and veined much like a leaf, and sometimes beset with large, conical, retractile papillæ. The Australian *Aneitea* (*A. Graeffii*) is found in New South Wales and Queensland, and according to Hedley may attain a length of about 5½ inches! This is also a very handsome animal, with its yellow ground colour ornamented with bands of red. An interesting account of it is given by Mr. Hedley in his paper "on *Aneitea Graeffii* and its allies,"† where a valuable summary of our knowledge of the Janellidæ will be found.

* Proc. Linn. Soc. N.S.W., vol. vii. [Ser. 2], p. 616.
† Proc. Royal Soc. Queensland, vol. v., part v., p. 162.

INSECTA

To give an adequate account of the cryptozoic insect life of Australasia would be a task far beyond the scope of the present address, and would, moreover, require the co-operation of several entomological specialists. Most of the large groups are represented in some stage or other of their life-history, the most conspicuous being the ants and beetles and various Orthoptera, especially cockroaches. The ants, perhaps, offer a more promising and less-worked field for investigation than any other group of terrestrial animals in Australia, and it is sincerely to be desired that some of our local naturalists will take the subject up and make a thorough investigation, not only of their systematic characters, but also of their habits and life-history. In New Zealand they do not appear to be so abundant, although some species are common enough. A number of Australasian species have been described by Forel and others, while observations on the habits of some New Zealand species have been published* by Mr. W. W. Smith, of Ashburton, to whom I am indebted for valuable information.

Some of the most curious cryptozoic animals which I have met with are the immature stages of certain Dipterous flies. One of these is, I am informed by Mr. Skuse, the puparium of *Microdon*. It is an oval, plano-convex body, nearly white in colour, and with rows of brown warts on the upper convex surface. Several species of this occur in Australia, and they constitute most puzzling objects even to a zoologist who sees them for the first time.

Both in Australia and New Zealand, Dipterous larvæ of the group Mycetophilidæ are frequently met with under decaying logs. These are slender worm-like creatures, commonly of a greyish or blackish colour, and less than an inch in length. They make very remarkable networks or webs of transparent slime, sometimes in thin threads studded with glistening dewdrops. Each larva supports itself in such a web, and can move both backwards and forwards in it with considerable activity, and in a fashion which reminds one of the rapid opening and closing of a telescope. They belong to a group of fungus-feeding flies, and probably live upon the moulds which infest the rotten wood on which they make their webs. Mr. Skuse has identified one of these web-making larvæ as that of *Ceroplatus mastersi*,† Sk., which he tells me is a black-looking fly about ⅓-inch long in body, and very common on windows in Sydney from September to March. In this case the larvæ and pupæ are luminous, but not the fly. I have recently found larvæ, very similar to those which I have observed in Victoria, in the Alford Forest, New Zealand; but these are not luminous.‡ It is doubtful also whether the common Victorian form belongs to *Ceroplatus mastersi*, for a series of beautiful drawings of the life-history, made by my friend Mr. C. C. Brittlebank, of Myrniong, Victoria, show a perfect insect differing considerably from the description of that species.

The "New Zealand glow-worm," *Bolitophila luminosa*, Skuse, is another member of the Mycetophilidæ, whose larva makes a slimy

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* "On the Origin of Ants' Nests"—Entomologists' Monthly Magazine, series 2, vol. iii., p. 60.

† *Vide* Proc. Linn. Soc. N.S.W., vol. iii., 1888, p. 1123; and vol. v., 1890, p. 601.

‡ It is very probable that these belong to a new species. Mr. P. Marshall, of the Agricultural College, Lincoln, has undertaken the investigation of their life-history.

web, but the situation in which it is placed is different in this case. Mr. Hudson states* that "the web referred to above is suspended in a rocky or earthy niche in the banks of streams in the densest parts of the forest." In this species the larva, pupa, and female fly are all luminous.

MYRIAPODA.

The centipedes and millipedes undoubtedly constitute a conspicuous portion of our cryptozoic fauna, indeed in the case of some of the larger forms one is sometimes inclined to wish that they were a little less conspicuous. Unfortunately I know of no concise account of our Australasian species, and of but few scattered memoirs on the subject, so that I am obliged to pass them over with bare mention. There is, however, one point which I would like to refer to, and that concerns the manner in which the eggs and young are carried about. During the past year there has been some correspondence on this subject in "Nature." Mr. Urich, writing from Trinidad, describes† how the eggs and young are carried about attached to the under surface of the parent; and Mr. Quelch, writing from British Guiana, makes similar observations‡ on the habits of the centipedes of that country. It may be worth mentioning that our Australasian centipedes are equally solicitous for the well-being of their young, for I have observed the same habit both in Australia and New Zealand. One must not, however, be too hasty in attributing parental virtues to the centipede, for Mr. Quelch also observes that, when deprived of food for a day or two, they "feed quite leisurely and greedily" upon their own offspring. The same writer remarks that cockroaches are their most desirable food in the tropics. Doubtless the centipedes are amongst the "beasts of prey" of the cryptozoic fauna, and one wonders how such an animal as *Peripatus* manages to hold its own in the struggle with such powerful adversaries. Possibly the fluid discharged from the oral papillæ is sufficiently tenacious to impede the movements of the foe, or even to glue his jaws together.

PROTRACHEATA.

So much has been written about the genus *Peripatus* during the past few years that I feel almost constrained to apologise for again venturing to introduce the topic. Any account of our subject would, however, be very incomplete without some notice of this important and characteristic form; and before passing on to what especially concerns the Australasian species, a few general remarks on the group may not be out of place.

Peripatus is usually found beneath stones or fallen logs. Sometimes it may work its way well into the interior of a rotten log as is, especially the case with the smaller Victorian species, *P. insignis*. In general appearance the animal resembles a moderate-sized caterpillar more than anything else, but may be readily distinguished, even by

* "The Habits and Life-history of the New Zealand Glow-worm"—Trans. N.Z. Institute, Zoology, vol. xxiii., p. 43. *See also* Norris, "Observations on the New Zealand Glow-worm"—Entomologists' Monthly Magazine, September, 1894.

† "Nature," 5th April, 1894.

‡ "Nature," 7th June, 1894. In this very interesting letter Mr. Quelch observes that the scorpions carry their young on their backs. It would be interesting to learn whether the same is true of our species.

the amateur, by the beautiful velvety texture of the skin and the large number of claw-bearing legs (fourteen to sixteen pairs in Australasian species). When first revealed by the removal of its shelter it appears lying quite still and motionless, apparently fast asleep. Gradually, however, the animal wakes up and stretches itself out, and when it has got all its legs into proper working order it can run at no inconsiderable speed. The colour and markings vary much, even within the same species. Thus in the larger Victorian species the prevailing colour ranges from a rich reddish-brown to a dark blue-black, though all the varieties appear to be deducible from one typical pattern.

The head is well provided with sense organs, consisting of a pair of beautifully ringed and highly sensitive antennæ, with a pair of very complex eyes near their bases. The mouth, surrounded by white tumid lips and provided with a pair of horny jaws, is situated on the lower surface of the head, and on each side of it is a prominent "oral papilla," bearing the aperture of a large gland which secretes the sticky fluid which the animal discharges at its prey. This fluid hardens in contact with the air, and firmly adheres to objects which it touches.

Captain Hutton, in his description of *Peripatus novæ-zealandiæ*, makes the following interesting observations on their habits:—"They are nocturnal, but will feed in the daytime when hungry. They feed upon animals. I have seen one shoot out its viscid fluid from the oral papillæ at a fly introduced into the jar in which it was confined, and stick it down; it then went up and sucked its juices, rejecting the whole of the integument."*

Nearly all the known species of *Peripatus* bear their young alive and very fully developed, the period of gestation extending over thirteen months. Until recently this was believed to be the universal rule, but, as I shall have occasion to show presently, the larger Victorian species forms a notable exception, in that it lays eggs with exquisitely sculptured shells, from which the young emerge only after an interval of many months.

The great interest attaching to *Peripatus* lies in the fact that it appears to form a sort of connecting link between the segmented worms and the insects, or, to speak more exactly, the *Tracheata*. The most important vermian character is the presence of excretory organs in the form of segmentally arranged nephridia, which are never found in true *Tracheata*. The slit-like openings of these funnel-shaped nephridia are easily seen on the under surface at the bases of the legs, and the nephridia themselves agree closely in general characters with those of such animals as the earthworm. To my mind, however, the tracheate characters of *Peripatus* far outweigh the vermian, for the animal agrees with the former and differs from the latter group in such important features as the possession of tracheal tubes for respiratory organs; the presence of claw-bearing appendages and the formation of the jaws by modification of some of these; the presence of ringed antennæ; the very feeble development of the circulatory organs, and the presence of a tubular dorsal heart with paired ostia. The fact that one species lays eggs with definitely sculptured

* "On *Peripatus novæ-zealandiæ*"—Annals and Magazine of Natural History, November, 1876.

envelopes may also be indicative of an affinity with insects rather than with worms. On the other hand, *Peripatus* has certain structural features peculiar to itself, such as the slime glands and oral papillæ.

For these reasons it has been proposed by Hæckel to place *Peripatus* in a group by itself, and to this group he has given the name *Protracheata.* We may suppose the *Protracheata* to be descended, without very much modification, from the common ancestor of worms and insects, although probably, as Captain Hutton observes, they cannot be considered as a direct link between these two groups.

Even apart from its anatomical peculiarities, the geographical distribution of *Peripatus* seems to indicate that it is an extremely ancient type. Like other forms which we have reason to believe are of great antiquity, it is now found at the southern extremities of the great land masses: at the Cape of Good Hope, in South America, and in Australia, as well as in various islands, as New Zealand and the West Indies. This peculiar distribution is accounted for on the supposition that *Peripatus,* like other forms of life, had its origin somewhere in the great land mass of the northern hemisphere, and that, owing to competition with improved and more perfectly adapted forms in the north, it was gradually driven to the southern extremities of the great continents, where the few surviving species now find a refuge in cryptozoic haunts.

That the differentiation of the species in these widely-separated localities has not gone sufficiently far to have become of generic importance in the eyes of the great majority of naturalists is a very noteworthy fact, probably indicating that *Peripatus* is a very persistent type, subject only to very slow modification. This persistence of structure is, perhaps, to be attributed to the similarity of the conditions under which *Peripatus* always lives, and to the more or less successful escape from the general struggle for existence in its hidden retreats.

It must be pointed out, however, in this connection, that Mr. Pocock has quite recently proposed* to subdivide the genus into three, using the name *Peripatus* for the Neotropical species, *Peripatoides* for the Australasian species, and *Peripatopsis* for the South African species. The anatomical differences upon which this classification is based are, however, very slight, concerning only the number of spinous pads on the legs and the distance of the generative aperture from the hinder extremity.

The history of our knowledge of the Australian species of *Peripatus* up to July, 1889, is given at some length in my observations on the subject, published by the Royal Society of Victoria,† wherein references will be found to the earlier writings of Saenger, Tryon, Fletcher, and Sedgwick. As we are at present dealing with New Zealand as well as Australian species, we must add to this list the important memoir by Captain Hutton on *Peripatus novæ-zealandiæ,* published nearly twenty years ago,‡ and the recent observations by Miss Sheldon§ on the development and anatomy of the same species.

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* Journal of the Linnean Society of London, vol. xxiv., p. 518 (1894).
† Proc. Royal Soc. Victoria for 1889, p. 50.
‡ Annals and Magazine of Natural History, November, 1876.
§ Quarterly Journal of Microscopical Science.

Up to 1889 Saenger's *P. leuckartii* was the only recognised Australian species, and Hutton's *P. novæ-zealandiæ* the only one from New Zealand.

Most unfortunately for subsequent investigators, Saenger's original description was published in Russian, in the Transactions of the Russian Assembly of Naturalists held at Moscow in 1867, so that few naturalists have the opportunity of seeing the memoir in question, and still fewer of understanding it. This is particularly unfortunate in view of the fact that a certain amount of doubt has of late years been thrown upon the question of the correct nomenclature of the Australian species, the facts of the case being as follows:—

The common species in Queensland and New South Wales possesses fifteen pairs of claw-bearing legs, and an accessory tooth on the outer blade of the jaw. The colour of the skin is a mixture of indigo blue and dark-red in varying proportions; and it is undoubtedly viviparous. The last-named fact has been emphatically demonstrated by Mr. J. J. Fletcher in recent volumes of the Proceedings of the Linnean Society of New South Wales, and I have lately had the opportunity of confirming his observations in the case of specimens from New South Wales and Queensland collected and given to me by Mr. T. Steel, Professor Spencer, and Mr. D. le Souëf. This species is universally accepted as *P. leuckartii*.

In Victoria, on the other hand, there are two species. The larger of these closely agrees with the northern form in size, general appearance, and anatomical structure; but instead of being viviparous it lays eggs, which have beautifully and regularly sculptured shells, and from which the young animals may emerge after an interval of more than a year from the date of laying! I believe that I have established these facts beyond dispute in my recent papers on the subject in the Proceedings of the Royal Society of Victoria and of the Linnean Society of New South Wales. This Victorian species has, as a rule, a more or less distinct pattern on the dorsal surface, consisting of a series of segmentally arranged diamond-shaped patches in which the red colour is predominant, but in the darkest specimens these patches are represented only by a row of small yellow or red spots on each side of the middle line. I had hoped that the presence of this pattern might serve as a means of distinction between the oviparous Victorian form and its viviparous congener in New South Wales. This hope was, however, destroyed by the dissection of a specimen collected by Mr. Steel at Blackheath in New South Wales, which exhibited clear traces of the diamond-shaped pattern, and at the same time contained numerous advanced embryos in the uteri. The internal anatomy of the two forms also agrees very closely; indeed I have not yet been able to detect any difference except in the appearance of the uteri, due to the presence of large, thick-shelled, regularly oval eggs, usually lying a little way apart from one another in the one case, and of developing embryos with very thin membranes, and usually more crowded together, in the other. Although I have dissected Victorian specimens taken in December, May, and July, I have never found any embryos in them (as opposed to undeveloped eggs), while in New South Wales such specimens are nearly always present. So the larger Victorian species, so far as we know at present, differs only from the northern species in its oviparous habit. How this difference can be accounted for is to me a perfect enigma, for I cannot believe that the slight difference in climate can have anything to do with it, especially in view of the viviparous nature of the New Zealand species. We can only hope that further observations may clear up the mystery, and in the meantime it may still be desirable to refrain from giving a distinctive specific name to the oviparous form, for it would be very awkward if we had to satisfy ourselves as to whether or not a particular specimen laid eggs before we ventured upon attaching a name to it. Of course it is conceivable that the oviparity of the observed individuals may have been abnormal, but the whole of the evidence afforded by the Victorian specimens appears to me to be against this view, and especially the presence of the remarkably sculptured eggshell.

The smaller Victorian species is undoubtedly distinct. It was discovered by Mr. H. R. Hogg, at Macedon, and described by me under the name *Peripatus insignis* in the "Victorian Naturalist" for April, 1890. It differs from the accepted *P. leuckartii* in the pattern of the skin, the presence of only fourteen pairs of legs, and the absence of an accessory tooth from the outer blade of the jaw. In this last character it agrees with *P. novæ-zealandiæ*. The Victorian specimens of *P. insignis* are much smaller than *P. leuckartii*, but Professor Spencer* has made the extremely interesting discovery that the species occurs also in Tasmania, and that there it attains a much larger size, about equal to that of *P. leuckartii*. Perhaps we may look upon Tasmania as the more proper home of this species.

Unfortunately, I now have to point out a further element of doubt which enters into the nomenclature of the Australian species of *Peripatus*. When in London, recently, Professor Spencer obtained a translation of Saenger's original diagnosis of *Peripatus leuckartii*, and of this he has kindly furnished me with a copy.

The diagnosis commences, "Found in New Holland, north-west from Sydney. Fifteen pairs of legs, one pair without claws, fourteen with." If this be correct, then the common Australian species usually accepted as *P. leuckartii* is certainly not the species described by Saenger under that name, for I can certify that it has fifteen pairs of legs, all of which bear claws. There appear to me to be two possibilities in the case (1) Saenger has failed to observe the claws on one of the pairs of legs, or (2) there were really only fourteen pairs of claw-bearing legs in his specimen, and he counted the oral papillæ as a pair without claws. It is difficult to say which of these alternatives is more likely to be correct, but it seems just possible that my *P. insignis* may be the real *leuckartii* with only fourteen pairs of claw-bearing legs. The only way to settle the question definitely would be by an appeal to Saenger's original specimen, which is stated to have been in the possession of Professor Leuckart. Perhaps some German zoologist may be able to undertake this task.

The mere question of nomenclature is, however, of secondary importance, and whatever conclusion may be ultimately arrived at with regard thereto will not affect the fact that in Australia three forms of *Peripatus* occur—a more northern viviparous form with fifteen pairs of legs, known as *P. leuckartii*; a more southern oviparous form with fifteen pairs of legs, which is, perhaps, specifically identical

* Proc. Roy. Soc. Vic., 1894.

with the last; and a fourteen-legged species known as *P. insignis*, which seems to reach its maximum development in Tasmania.

In New Zealand *Peripatus novæ-zealandiæ*, with fifteen pairs of legs, appears to be fairly common in certain localities both in the North and South Islands; and I have recently described, as a variety of this species, a form with sixteen pairs of legs from a locality (in the North Island) whence the genus had not hitherto been recorded. This form was represented by three specimens given to me by Mr. Henry Suter, after whom I have named it as a new variety. The only feature which, so far as I have been able to ascertain by careful examination and dissection, separates this variety from the ordinary New Zealand form, is the development of an additional pair of legs, a fact of considerable interest in view of the usual constancy in the number of legs of the Australasian species. Hence it appears that, while fifteen is the usual number of pairs of legs in the Australasian species, we have in Tasmania and Victoria a form with only fourteen pairs, and in New Zealand a form with sixteen pairs.

ARACHNIDA.

Spiders and other closely related tracheate Arachnida form a very prominent feature in the cryptozoic fauna of Australasia, being both numerous and varied. The literature of the group is, unfortunately, almost entirely unknown to me, and I have no observations of my own which are worth placing on record. The abundance of spiders in cryptozoic haunts may perhaps be partly accounted for by the abundant supply of suitable animal food found in such localities.

In Australia the true scorpions are also common, and it appears to me a very strange fact in distribution that they should be, so far as we know at present, entirely absent from New Zealand. One would imagine that their facilities for dispersal would be quite as great as in the case of other cryptozoic Arthropods, such, for example, as *Peripatus*, which occur abundantly in New Zealand. Indeed, one would expect a close similarity between the distribution of scorpions and that of *Peripatus*, for both belong to very archaic types, and the habitat of both is apparently identical. In Australia, according to Pocock, who has lately published an article on the Geographical Distribution of the group in Natural Science,* no less than six genera of scorpions are represented.†

The Pseudoscorpions, such as *Chelifer*, do not appear to be common in Australia, for I have only once seen a specimen, which came out of some firewood in Melbourne. In the South Island of New Zealand, however, I have found a large species, probably of *Chelifer*, very abundantly under stones near the banks of a creek in the Alford Forest; and it was interesting to note that, like the centipedes, they carried their eggs about attached to the under surface of the body in a spherical mass.

CRUSTACEA.

Small terrestrial Amphipoda and Isopoda are very frequently met with under logs and stones and dead leaves. Of the former group the shrimp-like *Talitrus sylvaticus* (Haswell), of Australia, and

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* May, 1894.

† Viz.: *Hormurus, Urodacus, Cercophonius, Isometrus, Archisometrus, Isometroides.*

Orchestia sylvicola (Dana), of New Zealand, are common examples. In the latter group we have the very common Australasian wood-louse, *Porcellio graniger* (White), found both in Australia and New Zealand, and especially abundant in gardens, while various other forms are also to be met with belonging to the genera *Oniscus*, *Armadillidium*, and *Cubaris*.

Very little indeed appears to be known of the Australian cryptozoic Crustacea, however. Mr. G. M. Thomson, of Dunedin, to whose kindness I am indebted for the identification of the few species which I have myself collected, is working at the group, and we may soon expect a rapid advance in this direction. It is to be hoped that some attention will also be paid to the habits of these animals. It is a singular fact that, as pointed out by Semper in his work on "Animal Life," these small Crustacea, with practically identical anatomical structure, should adopt both marine and terrestrial modes of life.

The remarkable burrowing crayfish of Australia (*Engæus*) can hardly be considered as a Cryptozoic animal, but occupies much the same position with regard to habitat as do the earthworms.

OLIGOCHÆTA.

Owing principally to the extensive researches of Messrs. Beddard and Fletcher and Professor Spencer, a large number of Australian species of earthworms have been described. It is, however, doubtful how far any of these numerous species can be considered as normally cryptozoic in habit, unless the use of that term be extended to all burrowing animals. That earthworms are commonly met with beneath rotten logs in Australia and New Zealand is a fact well known to every collector, but it remains to be shown that the same species do not also burrow in open ground in the ordinary manner. Mr. Fletcher is doubtless correct in attributing the frequent occurrence of earthworms under logs and stones to the fact that such situations retain moisture longer;* but at the same time it is very likely that some species may occur exclusively under or in rotten logs, being attracted thither by the food supply afforded by the decaying wood. Several Australian species have, I believe, as yet been found only in such situations; as, for example, a species of *Perichæta*, described by Professor Spencer,† which I found in rotten wood at Healesville, Victoria.

NEMERTINEA.

The Land Nemertines are amongst the rarest of terrestrial animals, and everything known about them points to a comparatively very recent derivation from marine ancestors. Professor Semper, indeed, states that they show not the smallest difference from their nearest allies living in water.‡ Only six species of Land Nemertines are as yet known to science. The first was found by Professor Semper in the Pelew Islands, and described under the name *Geonemertes palaensis*. Another was discovered, on the "Challenger" Expedition, living in

* "Notes on Australian Earthworms," part i.—Proc. Linn. Soc. N.S.W., vol. i. [Ser. 2], p. 525.

† "Preliminary Notice of Victorian Earthworms," part ii.—Proc. Royal Soc. Victoria, for 1892, p. 12.

‡ "Animal Life," p. 188.

damp earth at the Bermudas, and was described by the late Dr. von Willemoes Suhm under the name *Tetrastemma agricola*. A third has been found in Germany, and named by Professor von Graff *Geonemertes chalicophora*. Its proper habitat is doubtful, as it seems very likely to have been introduced with exotic plants. A fourth occurs in the Island of Rodriguez, and has been described by Mr. Gulliver under the name *Tetrastemma rodericanum*. The fifth was discovered by myself in Australia, and named *Geonemertes australiensis;* while quite lately I have found a sixth species in New Zealand, for which I have proposed the name *Geonemertes novæ-zealandiæ*.

These remarkable little worms are in general appearance very similar to Land Planarians; so much so that anyone but an expert is certain to mistake them for such. Thus I found my first two New Zealand specimens in two miscellaneous collections of Land Planarians preserved in spirits of wine, and even when I shortly afterwards found the same species alive under logs in the bush, I took the first specimen home under the impression that it was a Land Planarian. A little judicious irritation, however, very soon causes the animals to reveal their true nature in a most unmistakable, and at first sight surprising, manner, for they suddenly discharge from an aperture at the anterior end a long white proboscis, sometimes as large as themselves, and then gradually withdraw it again into the body. This proboscis is certainly the most characteristic thing about the Nemertine worms, and at once serves to distinguish them from the more lowly-organised Land Planarians. It is a very highly specialised organ, with a very elaborate nerve supply, and, in the subgroup Enopla, to which the terrestrial as well as many aquatic species belong, it is provided with a marvellously complex armature, consisting of a central calcareous stylet, a number of reserve stylets, whose function* appears to be to replace the central one when it is broken, and a poison gland, with reservoir and duct for applying the poison to the stylet. I am not aware that anybody has yet observed how these animals use their complex weapon under ordinary circumstances, but there can be no doubt that it is a weapon of offence or defence, probably of service in capturing living prey, though what the nature of the prey is I do not know.

The habits of Land Nemertines are very similar to those of Land Planarians. They are found in the same situations, under logs and stones, and they move about in the same manner, by means of the cilia on the integument, assisted probably by the body muscles. So long as they are undisturbed they either lie quite still or crawl about with the proboscis entirely withdrawn inside the body, and it is only when they are irritated that it is shot forth. The anterior end is richly provided with sense organs in the form of eyes and very complex ciliated pits, and is moved from side to side as the animal goes on its way.

In the method of depositing their eggs the Land Nemertines, judging from the Australian species, in which alone it appears to have been observed, agree with some of their marine relatives and differ widely from the Land Planarians. The eggs are small and deposited

* This function has lately been disputed by Mr. Montgomery (Zoologischer Anzeiger), but it is difficult to see any other explanation of their presence, and the balance of evidence still appears to me to be in favour of the older view.

in clusters, embedded in a common transparent gelatinous mass, unprotected by any cocoon, and shaped something like a sausage.*

As already indicated, the Australasian cryptozoic fauna is exceptionally rich in the possession of two of the six known species of Land Nemertines. *Geonemertes australiensis* differs from all the others in the possession of a large number of eyes in place of the four or six commonly met with.† Since it was first discovered it has been found pretty abundantly in various parts of Victoria, and a probably identical species has been met with in Tasmania and New South Wales. It is a very remarkable fact that while the genus *Geoplana*, amongst Land Planarians, exhibits such great variation in colour and pattern, and is consequently subdivided into so many species, the genus *Geonemertes* exhibits scarcely any variation in colour and pattern throughout those parts of Australia where it has been found, so that we can only recognise a single Australian species. This fact appears the more noteworthy when we consider the close similarity in habits and habitat of the two genera.

The New Zealand Land Nemertine (*Geonemertes novæ-zealandiæ*) differs conspicuously from the Australian form in the presence of only four eyes—two large and two small—and also in the very well defined pattern on the dorsal surface. Only four specimens are as yet known, so that it appears to be very rare. Although coming from two very widely separated localities in the South Island, these specimens all agree in the peculiar arrangement of dark chocolate brown stripes on the back, two broad inner ones and two very narrow outer ones, separated by intervals of pale yellow colour.

TURBELLARIA.

The first Australasian Land Planarian known to science was collected by Charles Darwin in Tasmania, on the celebrated voyage of the "Beagle," just half a century ago (1844). It was described in the Annals and Magazine of Natural History,‡ under the name *Planaria tasmaniana*, but is now recognised as a species of *Geoplana*. Some interesting notes on this species are also given by Darwin in his Journal of Reseaches, although the statement that the animal feeds on rotten wood appears, in the light of later knowledge, to be incorrect.

No further progress was made in our knowledge of this group of animals in Australasia until 1877, when the late Professor Moseley described§ several species obtained during the voyage of H.M.S. "Challenger." One of these was obtained in New Zealand and described under the name *Geoplana traversii*,|| while three others were obtained in New South Wales and referred by the author to a new genus, *Cœnoplana*, with the specific names *cærulea*, *sanguinea*, and *subviridis*. The next Australasian naturalist who dealt with the group was Captain Hutton, who in 1880 described¶ two more species of New

* Dendy, "Notes on the Mode of Reproduction of *Geonemertes australiensis*"—Proc. Royal Soc. Victoria for 1892.

† The anatomy of *G. australiensis* is described in detail in my paper "On an Australian Land Nemertine" Proc. Royal Soc. Victoria for 1891.

‡ A. M. N. H., vol. xiv. (1844), p. 246.

§ Quarterly Journal of Microscopical Science N.S., vol. xvii., p. 273.

|| The anatomy of this species is dealt with in some detail by Professor Moseley.

¶ Trans. N.Z. Institute, vol. xii. (1880), p. 277.

Zealand Land Planarians under the names *Geoplana Moseleyi* and *Rhynchodemus testaceus*, of which the latter has since proved to be identical with Moseley's Australian *Cœnoplana sanguinea*.

Seven years later, again, the subject was taken up by Messrs. Fletcher and Hamilton,* who, in addition to giving an interesting account of the habits of these animals, described fourteen new Australian species,† including the first genuine species of the genus *Rhynchodemus* found in Australasia. They also showed that Moseley's genus *Cœnoplana* was founded erroneously, and that the species described under that name must come under the old genus *Geoplana*.

In 1888 I began to work at the group in Victoria, at the instance of Professor Spencer, who placed in my hands for investigation a very fine species collected by himself on the Upper Yarra. This species (*Geoplana Spenceri*) I dealt with as exhaustively as I could from an anatomical and histological point of view, and the results obtained were published in my memoir "On the Anatomy of an Australian Land Planarian."‡

Since then work on the group in Australasia has been confined almost exclusively to the description of new species.§

Since 1888 our knowledge of the group from a systematic point of view has increased steadily, numerous new species having been described from various parts of Australasia. The Australian species have been described for the most part in the Proceedings and Transactions of the Royal Society of Victoria, and I have also communicated a few notes on the subject to this Association, and to the Linnean Society of New South Wales. A most interesting collection from Lord Howe Island, including the remarkable new genus *Cotyloplana*, was described by Professor Spencer in the Transactions of the Royal Society of Victoria for 1891; while during the past year I have communicated papers to the New Zealand Institute and to the Annals and Magazine of Natural History, in which a considerable number of New Zealand Land Planarians are described.

Altogether we now know somewhere about 60 species of Australasian Land Planarians, but it is impossible to give the exact number until questions of synonymy are more definitely settled. That very many more species remain to be described cannot be doubted, for it is only in comparatively few localities that the group has been systematically investigated. Thus from Western Australia not a single species has yet been described; from South Australia we know only two; from Queensland, only six; from Lord Howe Island, eight; from Tasmania, nine; from New South Wales, eighteen; from New Zealand, twenty; and from Victoria, twenty-seven.‖ These numbers are in proportion to the amount of work which has been done in the different localities, and we may evidently still hope for a large increase in our knowledge of the group.

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* Proc. Linn. Soc. N.S.W. [Ser. 2], vol. ii., p. 349 (1887).

† Several of these species appear to me to be synonymous.

‡ Trans. Royal Soc. Victoria, vol. i., part 2, p. 50.

§ Additional anatomical information will be found, however, in my paper "On the presence of Ciliated Pits in Australian Land Planarians"—Proc. R. S. Victoria, N.S., vol. iv., p. 39.

‖ These numbers include species like *Bipalium kewense*, which have doubtless been introduced, and also well-marked varieties.

There is good reason to believe also that our knowledge of these animals on the anatomical side will be largely augmented in the near future, for within the next year or two we may expect to see Professor von Graff's great Monograph of the Land Planarians, and I am glad to be able to say that he has had a large number of Australian species for investigation.

Having thus briefly epitomised the history of our knowledge of this group in Australasia, we may pass on to the consideration of some of the more interesting facts which have been brought to light concerning the animals themselves.

The Land Planarians are an offshoot from the great marine group of *Turbellaria*, which also has a certain number of representatives in fresh water. They are elongated, more or less flattened, and very soft-bodied worms, whose general appearance has earned for them the popular title of "leeches" in some parts of Australia, where they often occur in great numbers, more than fifty specimens being sometimes found beneath the same log. In size they vary greatly, from the minute *Geoplana minor* of Queensland, which measures less than an inch in length when fully extended in life, to the large *Geoplana triangulata*, var. *australis*, of New Zealand, of which a specimen in the Dunedin Museum measures eight inches in length even after preservation in alcohol! They crawl about with an easy, gliding motion, in great part due to the abundant cilia with which the integument is clothed, and which clearly indicate the aquatic origin of the group. The integument at the same time secretes a copious sticky slime, which doubtless facilitates the action of the cilia, while at the same time it is of service in firmly holding their living prey. As they crawl the anterior extremity, which is richly provided with sense organs in the form of minute eyes and ciliated pits (probably olfactory in function), is uplifted and gently moved about as if prospecting the way. In the daytime they are rarely found abroad, but at night they may come out and move about freely.

Considering their love of darkness, it is extremely difficult to explain the reason why Land Planarians are so gaily coloured. The colours are arranged in longitudinal bands, streaks, or specks, and are of every shade: white, red, yellow, green, blue, brown, and black, often associated in very beautiful patterns. I have suggested elsewhere* that the very conspicuous colouration of certain species may come under the category of warning colours, and thus serve to protect the animals from birds when they do happen to venture forth in daylight; but much more evidence is required on this point. Latterly I have observed species in New Zealand which so closely harmonise in colour with their surroundings that one is tempted to consider them as instances of protective resemblance. Thus *Geoplana triangulata*, var. *australis*, occurs abundantly in the beech forest in the South Island of New Zealand; and the two shades of colour which it exhibits—dark-brown on the dorsal and yellow or orange on the ventral surface—almost exactly match the dead beech-leaves which strew the ground around its haunts, and which usually show either one or the other of these colours. *G. gelatinosa*, again, from the

* Trans. Royal Soc. Victoria, vol. 2, part 1, p. 69.

South Island of New Zealand, is a very peculiar species whose colour and markings form a close imitation of the wet, rotten bark on which it was found, and on which it was almost indistinguishable, like a mere slimy patch.

We know now that Land Planarians habitually feed upon living prey, such as insects and earthworms, the soft parts of which are ingested by means of the protrusible, sucker-like pharynx, the Planarian holding its victim in a sticky embrace the while. Probably owing to their fondness for earthworms, some species have taken to living habitually underground. Such, for example, is *Geoplana triangulata*, a large brown species which I frequently turn out of the soil when digging in my garden near Christchurch, and which certainly feeds upon earthworms. The Australian *G. sanguinea* (*G. alba*, &c.) is also sometimes found underground; and so is the allied Tasmanian species, *G. typhlops*. The last-named species is very remarkable, owing to the fact that it has entirely lost the numerous eyes characteristic of its congeners, a fact which I am inclined to attribute to its having taken to a more or less completely underground existence. A similarly blind species, described by Diesing under the name of *Geobia subterranea*, occurs in Brazil, and is said to live underground in the holes of an earthworm, upon which it preys.* Both these eyeless species are white, and this is certainly a very suggestive fact. Doubtless the presence of eyes in other species and the rich colouration are both to be associated with an occasional exposure to the light.

The development of Land Planarians is a subject about which practically nothing is known, and which would probably well repay patient investigation, especially if studied in comparison with their marine allies. Several eggs, associated with a large quantity of liquid, milky yolk, are deposited together in a spherical or ovoid capsule of horny consistence. When first laid these capsules are of a reddish-brown colour; but in the course of a few hours the colour changes to shiny black. They are found abundantly in spring and summer in cryptozoic haunts;† and in the case of *Geoplana Fletcheri* the young take about a month to develop up to the time of hatching, when the cocoon splits open. The cocoon is large in proportion to the size of the worm, and before it is laid causes a great swelling to appear in the hinder part of the body. Until recently I have always assumed that it passes out through the aperture on the ventral surface; but latterly I have observed in the case of *Geoplana triangulata* that it may pass out through the back of the animal, a large aperture, probably of a temporary nature, being visible after the event. This took place in captivity; but it is quite possible that the habit may be general.

Some Land Planarians possess a remarkable power of regeneration of lost parts, so that when the animal is cut up into lengths each piece may grow into a new individual. This fact was observed fifty years ago by Darwin in the case of *Geoplana tasmaniana*;‡ and of late years the same phenomenon has attracted a good deal of attention in the case of *Bipalium kewense*, an introduced species common in many

* *Vide* Moseley, Quart. Journ. Micro. Sci., N.S., vol. xvii., p. 289.
† Buried in the soil in the case of *Geoplana triangulata*.
‡ *Loc. cit.*

parts of the world, including Australia and New Zealand. The last-named species, indeed, would seem to adopt this plan as an ordinary method of multiplication.*

Only four genera of Land Planarians are known to occur in Australia—namely, *Geoplana*, which is by far the commonest, and which is characterised by the large number of minute eyes (absent, however, in *G. typhlops*) and the absence of differentiated head and anterior sucker; *Rhynchodemus*, comparatively rare, and distinguished from *Geoplana* by the presence of only a single pair of eyes; *Cotyloplana*, lately described by Professor Spencer, from Lord Howe Island, and characterised by the presence of a single pair of eyes and an anterior ventral sucker; and *Bipalium*, evidently introduced into these colonies by man, and at once recognisable by the characteristic cheesecutter-shaped head.

Although the genera are thus easily distinguished from one another, the question of specific distinction is one of some little difficulty. Experience, has, however, shown beyond doubt that for practical purposes the colour and pattern, associated with the shape of the body and the position of the external apertures, afford very good guides in recognising the species. That the pattern may sometimes vary considerably within the species no one need deny,† but this variation has its limits, and can be checked by the other characters mentioned. How far the results arrived at by the study of these external characters will be borne out by investigations upon the internal anatomy remains to be seen; and we may hope for much light on this question from Professor von Graff's forthcoming Monograph.

In the meantime it appears to me that we may not only distinguish the species by the external characters mentioned, but that we may also group them together in natural subdivisions of the genera. Possibly in the future each of these subdivisions may take rank as one species with a number of varieties, but it appears to me more likely that each will have to rank as a distinct genus. These points can only be determined by a careful study of the comparative anatomy of the group.

As regards the geographical distribution of the Australasian Land Planarians, we must wait for more extensive investigation before we can venture to draw any general conclusions. Meanwhile, the following facts may be pointed out:—The widely distributed genus *Geoplana* occurs in all the Australasian colonies where it has been sought for, with the curious exception of Lord Howe Island. *Rhynchodemus* is much rarer; unknown in Tasmania, and with only two species in Victoria, it becomes more abundant in New South Wales, and extends to Queensland (where we have not sufficient data to judge whether it is rare or otherwise), while in Lord Howe Island it appears from the collection made by Mr. Whitelegge, and described by Professor Spencer, to be the dominant genus, associated with the allied but

* *Vide* Fletcher, "Remarks on an introduced species of Land Planarian" Proc. Linn. Soc. N.S.W. [Ser. 2], vol. ii., p. 244. Also Bergendal, "Studien über Turbellarien, i." Stockholm, 1892 (Kongl. svenska vetenskaps-akadamiens Handlingar, Band 25, No. 4).

† I have illustrated this variation in the case of *Geoplana Fletcheri*—Proc. Royal Soc. Victoria for 1893, Plate X.

curiously modified *Cotyloplana*. In the north of New Zealand (Auckland) *Rhynchodemus* has been collected by Mr. Steel; but, as I have pointed out elsewhere, it is quite possible that it may have been introduced to this locality, a supposition which is strengthened by the fact that the only recorded species is indistinguishable from one occurring in New South Wales (*R. Moseleyi*), and occurs in the same locality as the undoubtedly introduced *Bipalium kewense*.

The geographical range of the numerous species of the group is a matter which can only be really satisfactorily discussed when the question of the delimitation of these species is more definitely settled. Meantime, it is very important that information should be collected and placed on record as soon as possible, for these worms are so easily distributed with plants by man's agency that already we are in danger of great confusion. Several species are known to occur in gardens in various parts of Australasia, whose native home is quite unknown, and such may be expected rapidly to extend their range into the bush, where they are likely to be mistaken for indigenous forms. This is notably the case with *Bipalium kewense*, which, first discovered in the Kew Gardens, near London, has acclimatized itself in many parts of the world, its native country being still unknown. A similar case is that of the remarkable blue-tipped variety of *Geoplana cœrulea*, which is found in cultivated ground in Victoria, New South Wales, and New Zealand, but has never been met with in the bush. The most curious point about this case lies in the very slight difference which separates the variety in question from the ordinary form of *G. cœrulea*, commonly met with in the Australian bush, the anterior extremity of the body being blue in the former and pink in the latter. *G. ventrolineata*, again, is a very distinct species, which occurs abundantly in a nursery garden near Melbourne, but has been found nowhere else, and which may possibly have been introduced from some extra-Australasian locality.

Since my arrival in New Zealand I have naturally been much interested in comparing the Land Planarians of that island with those of the Australian mainland. Judging from the results obtained by workers in other invertebrate groups (*e.g.*, Land Mollusca) one would expect to find a very distinct Planarian fauna in New Zealand. At present I am acquainted with some two dozen New Zealand species, a few of which are still undescribed, and I find that though few of these can with safety be absolutely identified with Australian species, yet in several cases the differences are extremely slight, and not such as would, in my opinion, justify a specific distinction if the varieties were found together. It would seem as if many Australian species had slightly modified representatives in New Zealand, but at the same time it must not be forgotten that a number of very distinct forms have already been described.

In concluding this brief and imperfect sketch of the cryptozoic fauna of Australasia, I would again venture to remind the biological members of this Association of the large amount of work which still remains to be done in this section of our native fauna. Although the animals in question are small, and to the ordinary observer perhaps extremely insignificant, they are very far from lacking interest from a biological point of view. They offer problems of importance to the systematist, the morphologist, and the student of embryology; while I doubt not that the study of our cryptozoic fauna will in the future throw much light on the difficult problems of geographical distribution and variation. The student of variation would find in the Land Planarians especially a most profitable field for investigation, and one which it would be hard to beat in any other group of animals.

But one fact must not be lost sight of, and that is that the opportunities which we now enjoy will not be always with us. Not only will the agency of man result in greatly confusing the problems of geographical distribution, but our cryptozoic fauna must be largely exterminated in the near future by the wholesale destruction of forests which is now going on. At present this clearing process is to a large extent an advantage to the collector, for experience has shown me that it is far easier to find cryptozoic animals in partially-cleared localities, where they are collected together under the remaining fallen logs, than in virgin forest, where there is so much cover that the animals are widely scattered, and the search becomes very laborious. When the clearing process is complete, however, and the last logs have disappeared from the ground in any district, then we may expect to lose sight for ever of many peculiar forms which formerly dwelt there.

Section E.

GEOGRAPHY.

ADDRESS BY THE PRESIDENT,

BARON VON MUELLER, K.C.M.G., M. & Ph. D., LL.D., F.R.S.

THE COMMERCE OF AUSTRALIA WITH NEIGHBOURING COUNTRIES IN RELATION TO GEOGRAPHY.

In the first instance the duty devolves on me to express the sense of deep gratitude for the honour shown me by the Queensland Council of the Australian Association in calling on me to open the proceedings in the Geographic Section of the Brisbane meeting, and I am all the more impressed with the significance of the position accorded me, as your venerable President counts among the leading geographers of our time. It is becoming, therefore, that I should first of all pay homage to my revered leader, under whom I had the honour to serve in an extensive geographic enterprise well nigh forty years ago, when he, as the first, penetrated, and with horses only, into Central Australia from the north, and disclosed the northern termination of the desert gold country, of which Coolgardie is the southern limitation, and when, for the first time, the Australian continent was crossed from north-west to south-east. But Mr. Gregory, of whose presidency the meeting must be very proud, has many other claims on your recognition. Expeditions of his reach back into the first half of this century, when he began independent territorial exploration in West Australia, under such privations and scantiness of resources, at that early colonisation period, as cannot readily be realised by the thoughts of the present generation. With Eyre, the hero of 1840 and 1841 on Australian geographic fields, who, from a recent letter to myself, continues to maintain a most lively interest in explorations, and with Sir George Grey, who won his spurs still somewhat earlier, our President is one in the Nestor-Trio of Australian exploring leaders, while Dr. J. H. Browne, the only officer accompanying Captain Sturt in the first advance into Central Australia from the south as far as Eyre's Creek, can still enjoy in the South Australian metropolis the triumph of that achievement. Of Leichhardt's ever memorable first expedition of 1844-1845, a prominent member, my friend Mr. Roper, is, by the mercy of Divine Providence, yet, as a geographic worthy, among the living at our time. Mr. Gregory, however, can furthermore be proud of having held, irrespective of legislative duties, the prominent position of Surveyor-General through those three decades, during which the exploration of the greater part of Queensland was finished, and most of that vast area became mapped and claimed from the wilderness for settlements, many of the latter having risen already to villages, towns, and some even to cities, so that his honoured name will remain for ever identified with the whole wide colonial territory there. What this means within a single lifetime, is not readily grasped by our imagination.

From the first half of our century, Australian coast explorations have been made by officers of the Royal Navy. Among these veterans, Captain Pasco remains among us as one of the oldest, the President of the Australian Committee for Antarctic Researches, and a Vice-President of the R. G. S. A., being a son of Nelson's flag lieutenant in the "Victory," who hoisted the memorable signal, "England expects every man to do his duty." He served in Captain Owen Stanley's expedition for the founding of the settlement at Port Essington in 1838, and afterwards shared in the famous survey voyage of the "Beagle" till 1843, in the discovery of the Victoria River, which watercourse our President sixteen years later explored and mapped to its sources. Captain Pasco was among those who first rendered known and surveyed the Adelaide River, Port Darwin, Port Bynoe, the Albert River; subsequently as lieutenant he served in Bass's Straits, where, as well as in the Gulf of Carpentaria, geographic monuments exist in his honour, his later naval career having been on the Borneo and China coasts. This brings vividly to our recollection the brilliant services of Admiral P. P. King, the son of one of the earliest governors of Australia, his explorations rivalling in importance those of Flinders, who in turn might be termed a second Captain Cook on the coast of the vast Queensland territory, the distinguished President of the oldest branch of the Royal Geographical Society of Australasia, the Honourable Ess. King, as a naval lieutenant, accompanying him in some of his survey voyages. Another geographic Nestor claims our admiration, Admiral Sir George Richards, who surveyed about half a century ago on the New Zealand coast, prior to his filling the grand position, through many years, of Hydrographer to the Admiralty. Perhaps only one more remains living for our homage from among the gallant men who became historically immortalised by sharing in the early discoveries effected for geography during the present secular space of time—it is the last surviving officer of Sir James Ross's Antarctic expedition, the illustrious phytographer, Sir Joseph Hooker, President of the British Antarctic Committee, who was one of the surgeons and naturalists of the "Erebus." These thoughts of great achievements of the past can best, perhaps, be brought to a close by one more word on Flinders, who remains so prominently identified with Port Phillip, where Mr. J. Shillinglaw, the son of one of the earliest secretaries of the Royal Geographical Society of England, is now writing from extensive authentic sources a full biographic account of the splendid services of the earliest successor of Dampier and Cook in Australian naval fame.

We live in an island-continent of almost European expansion, surrounded by the free waves of three oceans, giving to the whole the same advantage of insular position which so largely contributed to the grand development of the British homelands on peaceful territory. We have not to encounter racial complications, because the transit of the most primitive of autochthones to the high phases of civilisation at the present age is too sudden to allow the plainest of all nomads, though under present conditions born as British subjects, to embrace without detriment the forms of social life dictated by the needs of the present age. We are as early settlers not exposed to combats with ferocious animals, and ophidian dangers are conquered by a physician of our own country and time. The marsupial lion, terrific as his namesake of Africa, which here also preyed on the gigantic creatures of Australian pastures, perished with them for ever at a past geologic period, and no process of evolution will ever restore them. We are exempt from seismotic disturbances, those terrors which even in the latest days befell Venezuela and some other regions, inasmuch as the active volcanoes, through geologic curves from Japan and the Sunda Islands to Mount Erebus, seem to act as safety-valves for our continent, a boon which we are apt to forget to be grateful for. We enjoy almost over the whole Australian expanse a salubrious clime, too dry for generating miasmatic exhalations, spaciously or continuously, and thus the comparative dryness of our atmosphere diminishes also the dangers of local contagious and infectious influences; and though this scantiness of humidity brings with it certain disadvantages, these are far outweighed by gains. Even where seemingly forbidding deserts prevail, the glittering of the noblest of metals gives a footing to enterprise, and, as a sequence, gives far-reaching resuscitating prosperity to rural effort, through the opening up of water-riches, hidden since the creation days of the present epoch. We furthermore, though widely deprived of navigable rivers, can seize on the facilities, which the levelness of most tracts of Australia affords, for the easiest communication across the whole continent in most directions. We live in winterless climes with a double spring, best appreciated by those enfeebled by sufferings who had to dread the severities of the frosty season in the lands of their ancestors, and thus in this division of the terrestrial world, unlike to Europe, we can rear all products of the intratropic zones, with a rural scope considered as a whole simply unlimited.

We live under the British sceptre, under the sway of that throne which reigns over the greatest territorial possessions on our planet. Strengthened by such a power, we are blessed by the high religious sentiment which in British communities prevails; and we have the additional boon that on soil the free gift to these colonies, we can build up our institutions unhindered by traditions, usages, and privileges of the past, in a youthful country where the discoveries, toilsomely gained through centuries in ancient countries, can be applied with the widest scope and ceaseless influences. Such then is the felicitous position of Australia, auguring for a great future. It devolves largely upon us as Geographers to take our part in conducting Australia to its greatest destinies.

The fields are immense for our action; they are not encircled by the outer boundaries of these colonies. We are expected also to take our share in carrying the torch of our science into the dark or unknown recesses of neighbour lands.

We are aiding to build up the happiness and rich wealth of our fellowmen in adjoining islands, and to derive mutual benefit also from new lines of commerce for our own communities, all the more urgent at a time when the means for Australian productiveness, and our facilities for conveyance, have overreached the demands on our supplies, a disproportion which has brought about extensive cheerlessness and even misery.

Your own great colony of Queensland six times larger than Italy, larger than Persia, and nearly half the size of China proper -has during the semi-century of its existence set a glorious example of what can be accomplished by high-minded and valorous activeness. Six and a-half millions of cattle and twenty-one and a-half millions of sheep browse on your pastures, and your annual output of sugar has reached already 60,000 tons. All honour to Queensland. Indeed, Australia as a whole seems to be the most productive of lands in proportion to its comparatively limited population, but few millions dwelling as yet in this continent. As for prospective celerity of communication, Lord Brassey has pointed out that future railway extension of ours, by bringing us within the nearest reach of the Indian line, will render communication from the south coast of Australia to London possible within sixteen days, electric railway speed being left out of consideration for this estimate. By practical tendencies a hold is obtained on the public mind, and substantial support is won.

Australia comprises territorially about one-third of the British Empire, and is readily occupiable throughout. Deserts and what, at first glance, may appear forbidden ground will vanish by further artesian borings, by more storage of surface water, by providing a closer tegument of vegetation against the effects of the heating sunrays, and by preventing, through strenuous measures, extensive ignitions and conflagrations of forests, of scrub, and grass, whereby the clime will become more ameliorated. The rest of the blanks on the Australian map will likely be all filled up before the century closes. Mining explorers are the most active at present, more especially in the interior of Western Australia. A born Queenslander, Mr. Carr Boyd, has taken there a prominent share in this work, more especially from the south towards Termination Lake. Lindsay has at his command vast means for crossing deserts, through whole herds of dromedaries, the first small caravan of these marvellous desert animals having, for Australia, been secured by Victoria not without some co-operation of the writer, and they thus were first proved as highly adapted to our dry inland regions. An ordinary camel team from South Australia to Coolgardie travelled lately 800 miles without any mishap. Ernest Giles, who was the first in this part of the world to use camels as draught animals, has taken the field once more for a two years' traversing and sojourning in the western auriferous wildernesses. Brave men are now pushing forward to Central Australia from the east. All this is foreboding enormously increased commerce, discoveries following discoveries of gold, and other natural resources becoming simultaneously unfolded.

After the lethargy of ages, while savage hordes roved over our continent, the young generation of the aborigines awakens to civilisation. Tattooing and other disfigurements will soon be only historic relics of the past. Even the Australian native ought to realise the value of rural estates as distinct properties of healthful families, as objects worth living for, and even he, in this part of the world, should be an active contributor to trade and commerce. Where the autochthone roamed he will see towns spring quickly even from the desert, where he encountered precariousness of mere existence.

Do we realise that the territorial extent of Western Australia actually comprises a ninth of the British Empire? and yet the whole population of European descent at present scattered over it equals as yet only that of York, of Southampton, or Greenock in the home countries, or Quebec in Canada, while the number of the aboriginal inhabitants is also proportionately insignificant. Not to speak of Australia, it has been shown also elsewhere how cities of first rank can arise with marvellous quickness. Such events, the present generation here is destined to witness at our own time, and nothing can speed this so much as the discovery of goldfields, because that most precious of all metals, whenever gained, is at once almost quite as much available in business transactions as coin, without appreciable deductions of the middleman, without the loss through protracted business transactions, and without other mediators of trade.

No wonder, therefore, when a Coolgardie almost suddenly emerges from an unknown solitude. May we not hope that soon still more will be done to facilitate the finding and also the working of auriferous deposits in Western Australia, where the gold-yielding area seems to stretch through considerably over 1,000 miles from south to north, with a width as yet not even approximately calculable, because blank stretches still exist on our geographic map comparable to the extent of some prominent European kingdoms.

Passing now from our own lands on to countries in other parts of the globe, more especially with respect to mercantile relations, we must find that commercial contact with eastern tropical African lands, now gradually and widely becoming disclosed to trade, is to us of paramount significance.

In our earliest explorations the difficulties of penetrating new regions seem sometimes almost insurmountable, but, after the first track is cut and the earliest road opened, the forbiddingness vanishes, and the change in the aspect of the landscape becomes both striking and rapid. Thus, when Stanley's seemingly infinite primeval forest, which separates the Congo sources from the Lake Tanganyika region, probably teeming with novel products, shall have become dissected by paths of communication to bring the produce of even the western tracts of Central Africa within reach of eastern traffic, a trade should there also spring up with the Australian colonies. The millions and millions of negroes, when settling into better homes, must assuredly soon become more extensive consumers of our commodities. Wheat-flour, incomparably above all other substances for vegetable aliments, must come largely into requisition; so potatoes from our fields. Beef and mutton, especially in preserved forms, can doubtless be supplied from our coastal regions much more readily than from mountains on existing roads in Eastern Africa. Bricks, hewn building stones, flooring stones, sawn timber of kinds resisting the inroads of termites would also be needed; so our wine, and along with all this an endless multitude of other articles, such as soap, saddlery, many kinds of implements, strong furniture of Australian manufacture to be supplied from here, kitchen vegetables, and orchard fruits of all kinds pertaining to temperate or cool climes. Even the simpler musical instruments would afford means for elevating and refining the native races, who are generally susceptible to the influence of musical art. I may be permitted to give to this address at once a practical turn by specifying and summing up what goods would be likely to figure prominently in our exports to the British colonies in eastern tropical Africa, omitting what are not productions of our own, but only transit goods. The articles which we could display are more varied and multitudinous than might be thought at first sight.* Respecting raw produce, tariffs and wages rates of course must largely influence the choice in these trading operations, though it may be expected that these will get gradually more equalised all over the world.

The imports from Eastern Africa could be only limited, as factories for working up raw materials available from thence are as yet but few in our colonies, and as the generality of tropical products are to us still closer at hand. But merchant vessels taking Australian freight to the eastern harbours of Africa could reckon on securing from there loading for London, and return with English merchandise to our ports.

With what gigantic strides any particular trade can advance could be exemplified by manifold instances. Thus, Mr. George S. Mackenzie some few years ago emphasised this by a striking fact. In 1875 the first box of dates was shipped from Busrah in Mesopotamia, but in recent years the export from that harbour has been 20,000 tons annually. What for tea and cinchona culture has been done in British India during the last two decades might be quoted as similar instances. The gentleman who effected the first shipment of rice from Burmah is still a living witness of noticing the export to have been in one of the latter years about 1,250,000 tons, at a value of more than £2,500,000 sterling. Sir John Kirk, the companion of Livingstone's first Zambesi expedition, brought under commercial cognisance the Landolphia climber for African indiarubber. Now, this substance of almost endless applicability has arisen, as Mr. Mackenzie remarks, to about £200,000 in value annually as shipped from Zanzibar. All such successes have been brought about in the first instance by geographic explorations, whether by naval surveys or by land expeditions, in which among all nations, considering the work of the world in this respect as a whole, Britain constantly takes the lead. The political outcome of all these achievements, through pioneers of our favourite science, has been to raise the British Empire above every other in territorial expansion and solid wealth, and to carry its language, as the prevailing one, over the greater part of the globe. But such considerations should give an additional impetus to further explorations, especially at a period when universal depression

* Some live stock, including horses, select breeds of fowl, flour, potatoes, dried fruits, timber fitted for various structures, including material for wood-paving of qualities resisting termites, railway sleepers, piles, compressed hay, chaff, stable corn, rural seeds, coals, honestones, strong shoes and boots, saddlery, blankets, mattresses, stockings and other coarse wool fabrics, ropes and cordage, soap, candles, preserved meat, whale oil, butter, cheese, wines, biscuits, vegetables, dried fruits, starches, vinegar, rough paper, furniture, agricultural implements, mining machinery, carts, carriages, boats, musical instruments, fire-bricks, gold ornaments and other jewellery; last, and not least, current coins of our own mints, perhaps for land purchased.

has paralysed in most parts of the world trading operations and business transactions, and new scope should be won by geographic efforts, both for rural and mercantile industries.

The paths of communication from the coast to Lake Victoria Nyanza lead, as is well known, over very elevated country up to heights of 8,000 feet, it being about half that altitude at the lake. As might be imagined, the climate in the upper regions is delightful, and the soil extensively fertile. Captain W. H. Williams (in the volume 1893-1894 of the Royal Colonial Institute) remarks that wherever a military station is formed the aborigines flock round it for protection and settlement. Grassy pastures abound towards the lake, on which herds of native cattle and also donkeys browse. Similar is the testimony of Mr. G. Mackenzie and other great authorities on tropical African geography.

Lakes Victoria Nyanza and Tanganyika are only 160 miles apart, and this shows how commanding the mercantile communication line would be even to as far as the Congo source. Game should also be plentiful, affording skins as a merchandise not unwelcome even here in our colonies. As timber trees occur only scantily at and near the lake, new extensive homes for our quick-growing and hardwooded Eucalypts would widely be found, especially for the Queensland species, the seed trade in this way being sure to represent a good sum annually for a long time to come. Superior breeds of horses, cattle, and sheep will doubtless soon also be introduced from here to these equatorial highlands as an additional outlet of Australian pastoral industries. The traveller above quoted regards, with others, Uganda as destined for the centre of a vast population of colonists; and Britain, largely through the East African Company, and therefore through commercial efforts, has there a permanent footing. Uganda is the upper key to the Nile waterways, and will eventually represent a river line of 3,000 miles, and it may influence also the traffic of Lake Tanganyika and others of the vast lacustrine basins. The road length surveyed from Mombasa—that being the most commanding port—to Lake Victoria Nyanza extends to 660 miles, rising to 8,500 feet. Settlers who hail from Australia should soon bring us into ready contact with these new fields for industrial activity of high promise. Railways are sure to open up within the next decennia easy access to many of these wide tracts of country. It seems that to Dr. Baumann the enviable credit is due of having penetrated recently to the remotest sources of the Nile, by tracing upwards the whole of the Kagera River as the principal feeder of Lake Victoria Nyanza. So far as the country at Lake Nyassa is concerned, the access is facilitated through the Shiré River, as emanating from the lake. There, also, many more new emporiums must necessarily soon spring up, to which Australian attention has not yet been practically directed, although steamers are plying already in these waters also. Coalfields exist on the Upper Shiré and in other regions of tropical Eastern Africa. On these tracts of country Merensky is one of the best and latest authorities. The most direct intercourse with the coast at a distance of 350 to 400 miles in a straight line would not be through British territory; but it can be foreseen that trade connections will arise southward, placing the Nyassa regions in payable communication with the northern terminus of the South

African railways through wheeled vehicles or animals of burden. This would bring as a result an augmented trade between Her Majesty's South African and Australian dominions; and we would, speaking figuratively, draw nearer then also to Mashonaland and Matabeleland, whence we hear such glowing accounts as regards salubrity, fertility, and golden riches through accurate recent works, such as that of Sir A. R. Sawyer, with numerous maps, issued in 1894. In view of business calculations it may be noted that the distance from Swan River to Zanzibar is not greater than from the Thames to the West Indies, about 4,500 nautical miles; while it is not quite so far as from Port Phillip to Java, but with an open passage across the ocean all the way, whereas the distance between London and Zanzibar by the Suez Canal is about 6,600 miles, involving besides costly dues. Only some few months ago the discovery of diamonds was announced from Mashonaland. We must wonder how so many of the East African treasures could have remained hidden up to the latest time—when Solomon sent for gold to Ophir; when Ptolemæus had a correct idea of the position of the Alpine Moon Mountains; when Barboza, a cousin of Maghellan, mentioned gold as still obtained at the ruins of Zimbabye in Mashonaland, revisited lately again by E. A. Maund, and within 1894 by J. T. Bent, the latter unearthing there Roman coins. Africa had, however, already been crossed from Angola to Mozambique, though more for trading objects than geographic researches—in travels of Pombeiros from 1802-1811. A distinguished indigenous Central African, Dr. M. L. Desai, remarked before the Royal Colonial Institute, some few years ago, that from the valiant native tribes accustomed to tropical heat could, in the modern sense, be created agriculturists, traders, mechanics, engineers, and soldiers, as loyal and grateful subjects of the British Empire. Indeed, scattered dwellings must soon rise to villages, and towns also, in tropical Africa. Enlightened government is necessary for the protection of life and property; roads for business progress; schools to provide liberal education for subsequent fitness in life; chapels and churches to speed spiritual welfare. Indeed, in these lands, new for higher civilising exertions in all directions, thousands of things are wanted if once we think of details; moreover, there is a special charm in settling on primeval lands glorying in natural freshness and rejoicing in rewardful toil.

Turning now to the east, we can get a fair idea of Australian prospects, in its mercantile contact with the South Sea Islands, when we reflect on what already has been accomplished for Fiji. According to Gordon and Gotch's "Handbook"—a work which for its practical excellence has but few rivals extant anywhere—the Fijian Group, with its 7,500 square miles, and with a population of only about 2,000 whites in a total of about 120,000, imported in 1892 goods to the value of fully £250,000 sterling, and had an export of nearly double that amount, comprising sugar to the value of about £300,000, copra £50,000, fruit (mostly bananas) over £60,000. More than 90 per cent. of this trade—remarkable for the comparative briefness of time in which it rose—is with the Australian colonies, including New Zealand. In British New Guinea, one of the most recent of colonised territories, the proportion of export to import is as a reverse to that of Fiji, but it has been created with surprising quickness, thanks to administration most admirable. Taking into account the largeness of the territory there, the magnitude of the resources, and a working power represented by 350,000 autochthones, we must be conscious that New Guinea will have a great future before it. I have not dwelt on this topic on this occasion to any great extent, because from your city emanated the momentous reports of the Hon. John Douglas and Sir William Macgregor, unfolding the splendid achievements, though only three of the Australian colonies gave substantial support to the Administration of British New Guinea. I felt all the more constrained to discuss the glorious prospects of the wondrous land of the birds of paradise because it is in the Queensland metropolis, where the fullest and most recent information only can be gained, and this indeed exists in a compact form, irrespective of the literary volumes of the bravest of missionaries, in the special work written some few years ago by the accomplished President of the Queensland branch of the Royal Geographical Society of Australia.

Let us remember also that part of South-eastern Papua, through interjacent islets, almost touches Cape York, suggesting the possibility of laying at inconsiderable cost an electric cable across. What a help that would be to bring New Guinea more under notice.

But one additional wish we might be tempted to express: the finding of a readily traversable pass from one of the southern harbours to the northern, so that a communication may be possible across the broad part of the peninsula without the necessity of a circuitous and intricate passage around the eastern point of the possession. For these reasons further highland explorations are still recommendable, inasmuch as from culminating points, irrespective of more geographic triangulations, the direction of the various watersheds would come into view with their comparative facilities for determining overland roadways. Then, also, a much further insight into the geology and the natural production—some, doubtless, of novel interest—of this part of the Papuan Island would then also be gained. The non-occurrence of volcanic eruptions and cyclones since the British occupation there seems singular, and would carry some exceptional advantages.

It must be a subject of rejoicing to all concerned that the administration of that possession will devolve for another term of four years on Sir William Macgregor, who, after the laborious and high-minded preliminary efforts of renowned missionaries—some martyrs to their cause and after the toils and wisdom of distinguished predecessors, has throughout that new colony fully established peace and safety there with increasingly hopeful prospects for expansive rural and mining industries. This will have increased shipping and mercantile intercourse in its sequence, and would help to relieve over-glutted productiveness of any Australian ports. The Governments of the three eastern colonies continue, in enlightened statesmanship, to afford even at a period of financial depression a most liberal subsidy to the Administration Fund; while the Royal Navy continues, by the prowess of the British flag and the splendour of its maritime surveys, to sustain and enlarge reigning supremacy also there.

The lengthened lines of river access will readily speed the development of New Guinean traffic. Rural introductions, fostered also from this colony, will wondrously augment the New Guinean resources and therewith its exports. Could we hope that, for the benefit of later times, even the Angora and Cashmere goat and the most eligible of deer may be transferred to the Papuan Alps? Could there, perhaps, the gazelles of Africa find a last refuge on almost inaccessible declivities, free also from ferocious pursuers, to preserve these poor innocent creatures of grace and utility from impending extinction? Even boats of British pattern in the near future are likely to supersede soon the native canoes, so that a ready sale ought to arise for the use of the aborigines. Frail pile-dwellings, no longer required for safety, and abandoned thousands of years ago as no longer needed in the lakes of Europe, will give way to buildings of commodious access and some approach to comfort. Imagine only the saving of time thus effected to the by no means unassiduous dweller.

To single out an instance of commercial or cultural possibilities either actually already, or prospective, let the gutta-percha trees be merely mentioned, and especially the best of them—*Palaquium Gutta;* it has for present practical purposes ceased to exist in its limited native area, and the few allied species will likely soon share its fate. Yet, of all the trees of the world, it is the most indispensable, so far as our present knowledge teaches us; by their product of gutta-percha for isolation of electricity they are the most wanted at the present time, and yet the least provided for. Unlike the very varied trees yielding caoutchouc in different intratropic regions, the gutta-percha trees are naturally restricted to the Sunda Islands and Malacca; moreover, they are slow of growth; hence the urgency of further searches after these precious and very select constituents of the empire of plants; and inasmuch as the vegetation of New Guinea and Polynesia is rich in Malayan forms, such searches by experts, particularly from Singapore—as first urged by myself—on those islands for new sapotaceous trees of the gutta-percha type would be exceedingly promising, and at once prove an expansive source for mercantile enterprise, more lucrative than ever, as by a new French process the incomparably useful substance could also be extracted from the foliage hitherto sacrificed. The English import of gutta-percha in 1892 was fully 4,000 tons, representing a value not far from a million sterling. As cellulose from pinewood has latterly greatly superseded other paper-material, and much changed the channels of supply, so also may in the progress of scientific research and applied technology other substances be detected which readily act as isolators; but the fact remains incontestable, if a comparison be allowed, that, even for so simple a substance of daily requirement as cork, no substitute either natural or artificial has been found. Hence the wisdom of planting cork oaks by the million in our Australian colonies as a lasting patrimony.

There must be indeed much in store for gains through extended commercial efforts as new regions near to us are opened up for civilisation. If we cast our views still further to the east, the "thousand islands," of which Marco Polo already spoke, spread gradually out before us. Britain secured, besides its Fijian and other insular possessions, the southern islands of the large Solomon Group. Here we are on primeval soils, though within so easy reach. Highly accomplished naval officers have also there almost completed the coast surveys. Heroic efforts of missionaries have paved the way to ingress of trade and culture, irrespective of the higher objects of these votaries of religion. The London Missionary Society, in its unceasing philanthropic efforts, sent out its new steamer "John Williams," built almost solely from savings of the school children of Britain, also on to these new shores, while the Royal Navy powerfully protects the settlements arising. All this augurs well. Sanitary measures are more carefully adopted in the choice of new abodes, and the savages without deprivation of their soil are vanquished now not so much by arms as by the awe inspired by the prowess of a great nation and the confidence inspired by their rules of justice. We are even told recently of the most precious of all metals as occurring there, and even of diamonds. The area may be counted for the British portion at 8,000 square miles with about ten inhabitants to each. Mountains of romantic aspect rise to 8,000 feet, rendering those islands well watered, and the already insular clime one of generally moderate temperature.

As is well known, several spacious and safe harbours exist. Intertribal warfare, decimating hitherto the local labour strength, is ceasing also there under the benign influence of civilisation. As for distance, we are not apt to realise that the majority of the Solomon Islands are about as far from the ports of Queensland as Moreton Bay is from Port Phillip, or St. Vincent's Gulf from King George's Sound. What products and what other merchandise can Australia send? The aspirations of the natives after trading contact with us will soon rise from the worthless brittle beads to substantial jewellery ornaments. The original hoop-iron will soon have lost its barter value and be superseded by implements of our own of European pattern, the crudest even no longer acceptable. Steel hand-mills, with which we early settlers in Australia used to grind grain raised on our own holdings, will be wanted everywhere by the Polynesians to crush their maize and sorghum. Fragile pottery will soon be extensively replaced by ironware; also at aboriginal homes iron pans will be in continued requisition for evaporating sea water to obtain crude kitchen salt. The primitive people of the soil will no longer be content with log dwelling and the shelter of palm-leaf roofs. Possession of brick buildings, with adequate furniture, European wearing apparel, boats and sails, structures such as we have, carts and draught animals, besides herds and flocks, will be their ambition, and that means ever-increasing exports from the neighbouring parts of Australia; and geography will also constantly be gaining from this in all its bearings. Comparisons of territorial extents cannot alone lead to any correct estimation of the prospects in any new colonisation; still it may give some idea of the final scope for merely rural operations there, when we consider that Mauritius contains only one-tenth of the area as compared to that of the British territory in the Solomon Group, or of the Fijian Islands, though its annual exports represent £3,000,000 sterling. Jamaica is only about half as large as the British Solomon Islands, yet its trade interchange is £750,000 sterling a year, although, in four centuries since its discovery by Columbus, the land became only in part cultivated. Barbadoes, with only 170 square miles in extent, maintains an annual export and import of over £1,000,000 each. According to remarks by Mr. C. W. Maxwell, at the Royal Colonial Institute, in the State of Perak, of only 8,000 square miles, but with a population of 213,000, the revenue of £55,000 in 1877 had risen already to £500,000 sterling in 1890, leaving a credit balance of £400,000. The State of Selangor, with only 3,000 square miles, but a population of 140,000, showed a revenue of £450,000 in 1890, leaving a surplus of £140,000. These splendid results are principally due to tin mines worked by Chinese; but among other products gambir is also much obtained.

We stand at the eve of great politic changes in Eastern Asia. The seclusiveness of China, which prevailed since grey antiquity, became broken in our very days, and must give way to significant reforms, affecting favourably the commerce and industries also in our Australian dominions. Japan, in an enlightened spirit, was in the van of these East Asiatic transformations, the results becoming strikingly manifest in events of the latest days; and the irresistible waves of human progress will sweep away more and more the antiquated prejudices, narrow-minded obstructions, and fanatic intolerance. It is as yet quite impossible to foresee how far and how soon these unavoidable transmutations will in all the recesses of Eastern Asia be triumphant; but the initiation is sure to be early, and the effect quick. It will be speeded by Russia's present gigantic efforts of rendering its vast territories in Northern Asia accessible through railway communication. These efforts are to some extent the sequence of a great geographic achievement—the renowned voyage of the "Vega." China, with its incalculably rich natural resources, especially also in coal, will be forced to follow these systems of expansiveness for transport through the world, linking the universal interests of mankind together for peace, prosperity, and worldly blessing. Even Japan, with all its progressive tendencies, will make still greater strides to attain an equilibrium with the status of the great nations. No longer will the movable mat dwellings, with their small carbon fires, remain of wide adoption. No longer will mechanic handicraft even there continue the main motor in its industrious life! Imagine merely the requirements of China for facilitating its internal traffic by means of ordinary wheeled conveyances of modern type. What an outlet opens thus alone for Australian factories from our many harbours! Our detail knowledge of geography will also profit from the pending alterations of national usages based on inveterate traditions in the far East of Asia.

The young Czar Nicholas II., with the most philanthropic views, inaugurates his reign doubtless in carrying out the thoughts or intentions of his imperial father, by entering on or continuing the construction of the above alluded to railway from the Ural to the northern boundary of Corea, a distance of about 5,000 miles, possibly involving an expenditure of £20,000,000 sterling. This contemplated steam communication by land will be three times as extensive as the one since some time in progress from Adelaide to Port Darwin, and may initiate new trade relations with our colonies, and, by its fitting in with the recently started Russian steam navigation line from Vladivostock to western North America, will bring about in those latitudes a direct encircling of the world. The line across Siberia will of course traverse many districts sufficiently populous, and therefore largely productive through working power, but will have to cope with an inclement winter clime. Thus South Australia may take courage at such a grand example by continuing its transcontinental railway, whereby the steam engine, never tired when fed, will bring our great southern land into still closer contact with Asia and Europe. We are all well aware that the construction of railways saves largely the formation and maintenance of ordinary road, though that palpable fact is often lost sight of. Western Australia will doubtless come across, at a time not very distant, by an extension of its railway system to the eastern colonies. In either case the impetus is given by continued gold discoveries in the direction of these two lines. The distance from Moreton Bay to various parts of Japan, if we revert once more to these islands, unique in every respect, is somewhat less than 5,000 miles, traversable in two or three weeks, and not much further than from Swan River to New Zealand. It would seem that the extensive import requirements of the crowded population there could yet be far more met from our colonies than has hitherto been the case. The subject is so large that it cannot even cursorily be dealt with on this occasion.

Let us go on now to British India, which comprises an area fully half as large as that of Australia, with about 260,000,000 inhabitants. As the well-being of the vast native multitude gradually increases under the wise British rule, the people's requirements increase commensurably, and so Australia will doubtless be able to share in providing the Indian wants.

Proceeding still further east, the resources of western South America become unfolded to us. Though situated within the same degrees of latitude as our colonies, so that we cannot effect an interchange of the products of season such as with countries in the Northern Hemisphere, yet Chili and Peru interest us much also in a commercial aspect. Scenically the contrast is great, especially through the snowy elevations of the Andes chain. There, in high lands, is the home of the llama, the alpaca, and the vicuña, which, though doubtless destined to be superseded as burden animals by the dromedary and Bactrian camel, and possibly even in tropical jungles the elephant, will afford during indefinite periods, also to come, their unique fleeces for fabrics, rivalling in lightness cotton apparel, but much exceeding the latter in warmth. In the same way we may from the vegetation there instance the nut Araucaria, allied to the famous Bunya Bunya of Queensland, which, as permanent food trees, are wanted by the million for cool humid tracts of any countries of the mild temperate zone. But from the mineral empire in nature a far more striking example may be adduced, the Chili saltpetre, an agrarian fertiliser not foreign to us here, but far too insufficiently utilised in Australia, as yet, for aiding in the resuscitation of exhausted tillage lands, always more readily defertilized in winterless zones, where cultures variedly proceed through the whole year.

A brisk direct traffic might be kept up for this mercantile commodity alone. Merely to the harbour of Hamburg this nitrate of sodium is annually shipped at a value of about £2,500,000 sterling, equal to 40 per cent. of the whole Chilian export, though not entirely for rural purposes. Bolivia and Peru likewise furnish this nitrate to a considerable extent. What can we offer in return? Chili imports timber largely, so that for our surplus of hard and decay-resisting eucalyptus wood there should be an additional outlet, wood bricks above all being now in universal demand. Probably the import of sugar and coal there could be still much more extensively served, and, therefore, also from our eastern shores; Mr. E. W. Knox estimating the sugar output of Eastern Australia this season to exceed by 25,000 tons our local consumption, now principally supplied on the far wider way from western Europe. These are mere examples of prospective international traffic carried into new or extended directions. Details can only be worked out after start and progress, as much will suggest itself after actual trading intercourses. Though various supplies might be drawn for western South America from the interior of Argentina, yet this can only be done at considerable freight expenditure, as the railway requires us to ascend, at the Uspallata Pass, to 13,000 feet. But the competition in these trans-Pacific interchanges, when the Isthmus of Panama shall have been penetrated, may become very much modified by the altered distances of voyages then. Will this century pass—the greatest in the world's progress—without the celebration of this achievement, which was initiated already by the crowned mighty grandson of Queen Isabella, who sent Columbus out on his glorious path, and of what has engaged the thoughts of bright spirits ever since? Imagine the grandeur of the enterprise, designed to effect for the Western world what the forcing of a waterway through the Suez isthmus has done for the Eastern; he who realised this project of ancient times now also having passed away. The resumption of the Panama scheme—just now announced, and as regards finances seemingly secured—must be hailed by all civilisation with delight. When the 300 feet elevation of the Culebra are once overcome, the main difficulty seems to have vanished, as through adequate hygienic measures the insalubrity of the clime can be lessened, and the inhabitants, when more settlements are thoroughly formed, can secure comparative safety. And what an influx of population with ever-increasing requirements, such as can partly be met from our colonies, will these works of world-renowned magnitude bring about merely for the immediate vicinity! All honour to the promoters in France who so perseveringly and so enthusiastically enter on a new effort, so brilliant, so promising, but which at one time appeared to be a forlorn hope. The United States, not to any surprise, wish to connect the Atlantic and Pacific Oceans by a passage of their own. Unforeseen complications, physical disturbances, especially in regions of earthquakes, tariff difficulties, would render a double line of transit at the junction of the two Americas not unwelcome, if even the contemplated Nicaragua Canal was on a lesser scale of capacity than that of Panama, and trade and commerce by both efforts would be still further augmented. From Greytown, where some harbour has been formed, to Brito, the length of the canal would be about 170 miles. A great length, to be sure, but about 140 follow existing water lines, naturally more or less navigable, the highest elevation to be pierced in both cases being nearly the same. It is anticipated that the waters of the San Juan, through the dam of Ochoa, will provide for forty miles a depth of not less than 38 feet. From the Toro to, and partly through, Lake Nicaragua, deepenings have to be effected. What requires to be done for the completion of the Panama line, so undauntedly commenced, is more generally known. To estimate these gigantic efforts of engineering skill for peaceful conquest in our own age, as the gift to nations and as historic triumphs, we might compare the construction of the stupendous Manchester Canal, of thirty-five miles length, at a cost of £15,000,000 sterling; the canal also for large ships connecting through Holstein the Baltic with the North Sea, of fifty-six miles length. The Suez Canal in its length of seventy miles had to overcome but slight elevations. The substantial gain from these colossal undertakings can approximately be estimated; the indirect advantages will ever be incalculable.

It is within remembrance of many still living that millions of their contemporaries never saw an ocean; and lived, as far as means for igniting was concerned, in the flint age.

Telephonic conversation, uninterruptedly and instantaneously, with clearness, is possible already at distances as far as Berlin from Vienna. In a still more powerful manner the ever-increasing extent of rapid locomotion is exercising its influence on commerce and industries, and renders new regions amenable to productiveness, formerly shut to exertions of civilised man. It is a transit period to some extent through which we live at present, and the means for industrial developments become so expanding, and the influence of the sciences and arts so powerful everywhere, that soon the torch of enlightenment will be carried into the all-remaining dark recesses of the world. The cessation of intertribal warfares in countries still of savagedom will set a vast amount of valiant labour free, formerly largely spent in futile, aimless, or even destructive combat.

Now, finally, a word to our young compatriots. The rising generation of Australian natives of European descent challenges in display of valour the entire world. The young Australians, as a whole, rival in loyalty the best of their British countrymen at home and abroad. Socialism, and the still greater horrors of modern times, as the outcome of misguided leaders of perverted mind, have not taken root on Australian soil. The good sense of our communities is sure to keep us free also from such evils in future. Young Australia bids fair to hold its own in all that is bright, whether in sciences or arts. It is endowed with talents second to that of no other country, and through prosperity here these natural gifts are in proportion to population more extensively developed than is possible in many other regions. Under our serene sky physical beauty becomes extensively created so as to contest anywhere for the palm. A sense of the æsthetic pervades the young population. A spirit of enterprise is generated and fostered by the ampleness of territory and openness of scope. Recognition of Australian destinies within legitimate bounds is evident. The youth of these colonies, following in the pious walk of most of their ancestors, is as extensively religious as even the rising generation in those parts of the globe where the most genuine Christian devotion prevails. Churches and charitable institutions in all directions bear witness to this. Our gracious Sovereign watches solicitously over the Australian dominion, and the strong arm of the great British nation guards us. Under such bestowals, Australia should advance to be one of the grandest and happiest among the great countries under the sway of the British throne!

Section F.

ETHNOLOGY AND ANTHROPOLOGY.

ADDRESS BY THE PRESIDENT,

T. WORSNOP, Esq.

THE PREHISTORIC ARTS OF THE ABORIGINES OF AUSTRALIA.

For many years after the settlement of Australia little was known of the sculptures, carvings, and paintings of the aborigines of this continent. The first to call attention to these were Captain Cook, Governor Phillip, Surgeon White, Captain Tench, Flinders, and the officers of the first Government on the establishment of the colony of New South Wales. These were followed by Mitchell, Grey, and the officers of the Imperial Navy when surveying the eastern, northern, and western coasts. Subsequently Leichhardt, Sturt, McDouall Stuart, Giles, Forrest, Kennedy, Gregory, and others have written of their discoveries of artistic paintings and carvings of the natives. They have been discovered delineated in caverns, in rock shelters, on rocks, and up on the now almost inaccessible faces of high cliffs. A mass of valuable and interesting data spread over a wide field has, during the last few years, rapidly accumulated, by means of which it is possible to study the rude and primitive ideas of the original artist. The origin of these rock sculptures and paintings is really a matter of absorbing interest, and the solution of the problem of their origin is one to be anxiously looked forward to. These unexplored fields will, on investigation, no doubt supply information of wondrous interest to all, for a halo of romance and mystery lies over them, which the traditions of the native race utterly fail to interpret.

The almost total absence of historical notices, relative to the aborigines of Australia, during the long ages that have passed since this continent was first peopled, to a period within little more than 100 years from the present time, precludes the possibility, in my opinion, of any satisfactory data from such a source being recovered upon which to base historical facts upon incontestable proof. We are, therefore, compelled to fall back upon artistic productions from which we may glean some evidence of the past life, history, and intercourse of the aborigines with other nations.

It is difficult, and for most people quite impossible, to realise the conditions of a race having to face the needs of a struggle for existence, where the animal kingdom presents more remarkable anomalies and peculiarities in its mammalia than in Australia. There is certainly a considerable variety of mammals indigenous to the country and peculiar to it, but amongst them all not one useful for labour or the carrying of burdens; so also was there a lack of cereals suitable for cultivation for human food.

Equally as peculiar and isolated as its flora and fauna are the aborigines, whose low social culture as a race stands in strange contrast to their fully developed speech. They had no implements wherewith to till the soil; they were equally ignorant of the art of making pottery, and their art of spinning was of a most limited character. These defects lead to the inference that the original family that reached these shores had left their primeval country before any of these arts had been discovered, their methods being so simple, and their results so useful, that, once known, it seems impossible they could ever have been lost. Having no earthen or metal vessels in which to boil water, their cooking is done either by broiling on or baking in the ashes, or by baking or steaming in a hole in the ground, which, although rude in appearance, is really so perfect that there is no wonder they did not seek for other means.

With numerous disadvantages, it excites our wonder and admiration to find in all parts of the continent works of sculpture and art, works of decoration, of peculiar cunning and handicraft, which, perhaps, few in this assembly have had the opportunity of seeing and admiring. These artistic efforts of the native race are of so singular and striking an originality, that they suppose a considerable knowledge of the methods of the sculptor, carver, and painter. In everything pertaining to his daily life the Australian aboriginal displays uncommon skill, and his arms and implements, though highly primitive, are well adapted to their purpose. The aborigines were keen observers of the indigenous animals, both land and sea, for they have accurately delineated their forms and figures. Rocks, isolated stones, animals, trees, in their opinion, all share with them the common gift of life—continually the visible universe suggests the invisible. To be alive now is the great mystery—the world to them is a museum of supernatural wealth and history. Norman Lockyer, in his "Dawn of Astronomy," speaking of the mythology of the Egyptians, says, "The apparent wealth of the mythology is dependent upon the totemism of the inhabitants of the Nile Valley—by which I mean that each district had its own special animal as the emblem of the tribe, dwelling in it, and that every mythological personage had to be connected in some way with these cults." So also have the aborigines of Australia, and many of these totems have been delineated on the rocks by them. We are apt to forget, in our consideration of the works of aboriginal art, that the world's grey fathers were children themselves, and that the beautiful works of art which adorn our homes and cities are the product of hundreds of years of patient teaching and toil; and with such knowledge we should deprecate too harsh a criticism on the works of art of the Australian native, and look on their ambitious flights of genius as betokening an intelligence which we cannot do otherwise than respect.

The copies of several paintings described in the Right Hon. Sir George Grey's "Journals of Expeditions in Australia" are not only remarkable in themselves, but give a most realistic motive in their design and colour. The ornamental value of human and animal forms is obvious when treated with judgment and skill. They give life, movement, and mystery to the place, such as would overawe the timid superstitious native mind. The description given by Sir George of the locality in which he found these works of art is certainly calculated to intensify the feeling of fear which the native imagination is too ready to create. He says—"The cave appeared to be a natural hollow in the sandstone rock; its floor was elevated about 5 feet from the ground, and numerous flat broken pieces of the same rocks, which were scattered about, looked at a distance like steps. These lead up to a cave, which was 35 feet wide at the entrance, and 16 feet deep, but beyond this several small branches ran further back. Its height in front was rather more than 8 feet, the roof being formed by a solid slab of sandstone about 9 feet thick, which rapidly inclined towards the back of the cave, which was there not more than 5 feet high."

On this sloping roof the principal figure (*Plate A*) of the series was drawn, and in order to give greater effect the surface of the rock round about it was painted black, the figure itself being coloured with the most vivid red and white; thus making it appear as if standing out from the rock. He thus describes the figure—"Its head was encircled by bright red rays, something like the rays one sees proceeding from the sun when depicted on the signboard of a public house; inside of this came a broad stripe of very brilliant red, which was crossed by lines of white, but both inside and outside of this red space were narrow stripes of a still deeper red, intended probably to mark its boundaries; the face was painted vividly white, and the eyes black, being, however, surrounded by red and yellow lines; the body, hands, and arms were outlined in red, the body being curiously painted with red stripes and bars." This imposing and awe-inspiring figure was not the only representation of the human form in this cave, for "on the left-hand wall, which partly faced you on entering, was a painting, very vividly coloured, representing four heads joined together, drawn in such a manner, and in such a position, as to look up at the principal figure," which he has described; and "each had a remarkable head-dress, coloured with bright blue, and one had a necklace on. Both of the lower figures (*Plate B*) had a sort of dress, painted with red in the same manner as that of the principal figure, and one of them had a band round its waist. Each of the four faces was marked by a totally distinct expression of countenance; and although none of them had mouths, two, I thought, were otherwise good-looking. The whole painting was executed on a white ground." The next most remarkable drawing in the cave was an ellipse, three feet in length and one foot ten inches in breadth (*Plate C*); the outside line was of a deep blue colour, the body of the ellipse being of a bright yellow, dotted over with red lines and spots, whilst across it ran two transverse lines of blue. This portion formed the ground or main part of the picture, and upon this ground the native artist had painted a kangaroo, two stone spear-heads, and two black balls. There was another sketch, representing a native carrying a kangaroo (*Plate D*). The number of drawings in this cave was from fifty to sixty, the majority of them consisting of men, kangaroos, &c.; these latter figures, being carelessly and badly executed, were surmised to have had a different origin to those first described. Another very striking work of art exhibited in the gloomy cavities at the back of the main cavern was the outline of a hand and arm, painted black, and the rock white, so that on entering that part of the cave it appeared as if a human hand and arm were projecting through a crevice admitting light. A somewhat analogous instance of native art is mentioned by E. Giles, in his explorations west of the Adelaide and Port Darwin telegraph line, where, in a cave, he saw depicted the body of a snake, with its head apparently in a hole in the rock.

Further remarkable discoveries were made by Sir George Grey, a short time afterwards, when he found another cave, and (cut out of the solid stone) discovered the profile of a human face (*Plate E*) fronting this cave. The head was 2 feet in length and 16 inches in breadth in the broadest part, the ear being rather badly placed, otherwise the whole of the work was good, and, he remarks, "far superior to what a savage race could be supposed capable of executing." The next day he found another cave, elevated at its entrance several feet above the level of the ground. In this was a painting of the figure of a man 10 feet 6 inches in length, clothed from the chin downwards in a red garment, which reached to the wrists and ankles. Beyond this red dress the feet and hands protruded, and were badly executed. The face and head of the figure were enveloped in a succession of circular bandages or rollers, coloured red, yellow, and white, and the eyes were the only features represented on the face. Upon the highest of the bandages or rollers were a series of lines painted in red, but although so regularly done as to indicate that they had some meaning, it was impossible to tell whether they were intended to depict written characters or some ornament for the head. On each side of the cave were representations of turtles and extraordinary animals, such as gigantic snakes (*Plate F*).

All writers on Australia describe the natives as devoid of the faculty of invention; and if this be so, it is all the more marvellous how, and by what means, the imagination of the natives could conceive and depict such striking representations as these above described. It is not unreasonable to suppose that the artist who painted these pictures, especially of the one clothed in so correct a dress, and again of the one first described with the circle of rays of apparent light, must have had intercourse with a people clad in some such garments, and their heads protected by some covering like turbans. Evidently the unknown artist loved his work, and these illustrations attest to the more than ordinary character of the untutored savage who drew them.

In the same distiict (near Kimberley, in West Australia), Mr. Harry Stockdale discovered a native art gallery on the McLeod River; the river running between immense cliffs from 200 feet to 300 feet high, and almost perpendicular, on the large smooth slabs of which were a great number of native drawings, occupying a space of fully twenty yards, and consisting of kangaroos, the platypus, and a figure *resembling a monkey*, blackfellows dancing the corroboree, the bust of a native woman, and many others, besides an excellent life-size drawing of an emu, depicted as feeding. Mr. Stockdale informed me "the drawing of the emu was true to nature and well done," and that "the whole of the drawings were filled in or shaded, and showed much artistic skill, the mouths of their faces alone being badly represented." Mr. O'Donnell, writing to me in 1886, said that he had found in the caves in the granite ranges in the Kimberley country, in West Australia, drawings by the natives similar to those found by Sir George Grey on the Glenelg River in 1836. Mr. O'Donnell furnished me with a copy of a native drawing painted on the rocks at this place, depicting a goose, and on its body a small kangaroo. The body of the goose is in white, and that of the kangaroo in red pigments; thus each is clearly distinguishable from the other. Mr. H. Stockdale also informed me that he had discovered on or near the Alligator River about forty caves, within a radius of 100 miles, in which were numerous native drawings of skeletons of human beings, laid out in regular lines, and hieroglyphics. Some of these drawings are remarkable indeed. In some cases the paintings are on the roof or ceiling of the caves. In others on the sides or walls. The drawings consist of animals, birds, reptiles, men, women, canoes, canoes with men in them, &c. Many of the drawings represent all the features of the face, several of them exhibiting European features and clothing. One very remarkable figure of a man has his arms crossed over his breast, with two little tufts or ornaments hanging from the crown of his head, and he has a necklace round his neck, the breast being covered with a device in straight lines, and the stomach with lines also at regular intervals. The face of this man, he said, was really well done. There were about 200 of these drawings at this place. He also found, not far from the place where Sir George Grey made his discoveries, some large caves full of native drawings, which he considered infinitely more wonderful. and thirty or forty times more numerous, than those named by Sir George.

On the Darwin River, near the bar, where the salt water meets the fresh, is a native camp with some excellent drawings on the surrounding trees. On the overland track between the northern stations of Queensland and Port Darwin, among the coast ranges, are some frescoes on the walls of a cave, consisting of representations of alligators, snakes, turtles, and starfish; but the chief of the drawings is the full length figure of a great blackfellow pursuing two little white men, who seem to be in such fear that their hair is standing on end; a third is lying prostrate with a spear thrust through his body. On the Upper Glenelg River, in West Australia, are paintings of native dogs, kangaroos, hooded lizards, emus, and one of a blackfellow trying to spear another. Emily's Gap, in the MacDonnell Ranges, in the centre of the continent, has been in times long past a favourite camping ground of the aborigines. Drawings are numerous here, and are coloured red, yellow, and black. The old men of the tribe at this place declare most emphatically that the rock paintings have had at one time an intelligent meaning, the significance of which has from the progress of time been entirely lost. On the Lizzie Creek are other native drawings. This place is about 100 miles west of Emily's Gap. There are some large caves at Mount Skinner and Ledan's Hill, in which are paintings of human hearts pierced in the centre by spears. The outline of the objects representing hearts has been delineated in red pigment, whilst the spear has been done in black (*Plate G*). These drawings consist of four separate representations, one above another, and exhibit a degree of perfection scarcely to be anticipated from these wild and untutored natives. These examples are most interesting, as the hearts are thoroughly typical in form. On the Finke River are two trees marked in a similar manner.

Gosse found paintings in Ayer's Rock representing two hearts conjoined. McDoual Stuart found a tree on the Hugh River marked with a heart, and further south be found two trees marked with these singular typical human hearts, as well as spear heads cut on the trees. In the eastern portions of the MacDonnell Ranges are several rock shelters on which are depicted snakes, lizards, the rising sun, a branch of an acacia, and numerous phallic marks. The females of the tribe are not allowed to approach the rocks, or even to look at them under pain of severe penalties. Other native drawings in these ranges represent two human figures. One, standing with uplifted hands, is characterised by the absence of a mouth, which is usually the case in drawings of the human figure by the native artist. The other figure is that of a man evidently killed by a blow from an abnormally large tomahawk. There is the usual snake, branches of acacia, emus' feet, a wheel-like mark, a representation of a grave, spear heads, phallic marks, the young moon, a tomahawk, a shield pierced by a barbed spear, and other fanciful marks.

On a creek joining the Victoria River, on the sandstone rocks, are several native paintings of fish and snakes. Not far from Glen Edith, in a cave discovered by E. Giles, are delineations of snakes and devices for shields, also an hieroglyph consisting of two Roman numerals—a V and an I. Placed together they represent the Roman VI; both are painted in red. On the Limmen Bight River, at Leichhardt's Crossing, are several interesting paintings on the rocks. At Chasm Island, near Groote Eylandt, in the Gulf of Carpentaria, Flinders found "rude drawings made with red paint on the white ground of the rock, representing porpoises, kangaroos, and a human hand"; afterwards he found the representation of a kangaroo with a file of thirty-two persons following after it. The third person of the band was twice the height of the others, and held in his hand a waddy or a wooden sword.

In Princess Charlotte Bay, on the north-east coast of this colony (Queensland), is an island known as Clark's Island, and Captain King describes a series of pictorial drawings found in galleries cut out of the rock by the action of the weather, which, he says, deserve to be particularly described. "They represented tolerable figures of sharks, porpoises, turtles, lizards, trepang, starfish, clubs, canoes, water-gourds, and some quadrupeds, which were probably intended to represent kangaroos and dogs." The figures here depicted exceeded 150. E. Giles saw in 1862, in caves at Monaro Mountain, about eighty miles east of Wilcannia, paintings of the human hand. He says—"On the rivers Murray, Edwards, and the Murrumbidgee, the natives ornament their shields and opossum rugs with representations of birds, fishes, and animals, which they have caught for food." He also states, when exploring in the MacDonnell Ranges, "that he noticed the natives have here precisely the same system of ornamenting the caves as the natives have in the Barrier Ranges, and in the mountains east of the Darling." The following (*Plate G*[1]) shows a cave on the Wollondilly River in New South Wales. The front of the cave is 15 feet wide and 12 feet high. On the back wall are a number of red hands, both of the right and the left. Under the principal hands are four white boomerangs. Paintings, the work of native artists, are found in all parts of the continent, in the Victoria cave in the Victoria Valley, colony of Victoria, and in caves near York, in West Australia. Mr. Mathews, a licensed surveyor of New South Wales, writes to me that he has received the medal of the Royal Society of New South Wales for his interesting papers read before that Society, describing fifty caves and their paintings, and forty carvings on sandstone rocks in that colony. The Palæontologist of the Australian Museum in Sydney (Mr. R. Etheridge, junr.) has also described, in the transactions of the Linnean Society of New South Wales, several very interesting and remarkable discoveries of rock shelters and caves in New South Wales, containing paintings and carvings of the native races.

The Ooraminna rockhole, on the overland telegraph line from Adelaide to Port Darwin, is one of the grandest rock waterholes on that line. This waterhole is in a small watercourse running down between the ranges. Where the hole is situated there is a waterfall having a drop of about 15 feet. The hole is almost round, and about 25 feet in diameter. Above the highest watermark there are several caves at the back, just under where the water falls, which have been profusely decorated by the natives. The principal drawings comprise sketches of emus' feet, human hands and feet, lizards, snakes, and scores of other mythical drawings. Close to, and, in fact, abutting on the rockhole itself are several other caves adorned similarly; one of them is, however, diapered all over with the design shown in *Plate H.* This diaper work covers a wall face of about 12 feet high by 16 feet wide, and is painted on a white ground with a red pigment. Access to this cave can only be obtained by passing behind the curtain of falling water; whilst medallions of the form shown at the bottom of the diaper also appear on the rock face. The red hand has attracted great attention, as the natives when questioned on the subject either declare their entire ignorance of the reason of its exhibition, or shake their heads, and, putting on an air of mystery, refuse to explain or satisfy the questioner. It will be observed that the hand is always in an uplifted position, never horizontal or having a downward tendency. At a place near Port Jackson (Sydney Harbour), on the rocks at Kangaroo Point, 30 feet above the present surface, are a whole series of hands painted in red still clearly visible. The number of hands depicted at this place is thirteen. The red hand is to be met with in almost all countries of the world—in Egypt, the Holy Land, Arabia, India, Babylonia, Phœnicia, and amongst the ruins of Mexico and Central America. On the Parramatta River there is a rock with seven of these hands depicted on it, but the most prolific place for them is Cox's Creek, near the head of the Cudgegong River. Whatever the pigment used may have been, it has so preserved the rock on which it has been painted, that the weather has had no effect on it, and the drawings stand out in relief from the other portions of the rock face. On the Hunter River are caves with representations of twelve hands in a row. All of these, with one exception, are those of the left hand. On the Natal Downs the natives have made drawings in the sandstone caves of emus, kangaroos, and the red hand. These latter are found on the almost inaccessible cliffs. On the Cape River are also a number of red hands. Indeed, wherever there are native paintings, there also will be found, with few exceptions, representations of the human hand.

Mr. Bradshaw, a station-holder on the Fitzroy River, stated to me that on the Prince Regent's River he saw numerous caves and recesses in the rocks, the walls of which were adorned with native paintings, coloured in red, black, brown, yellow, white, and a pale blue. Some of the human figures were life-size, the bodies and limbs very attenuated, and represented as having numerous tassel-shaped adornments appended to the hair, neck, wrist, arms, and legs (*Plates K, L, M, N*); but the most remarkable fact in connection with these drawings is that, wherever a profile is shown, the features are of a most pronounced aquiline type, quite different from those of any native he encountered. Indeed, looking at some of the groups, one might almost think himself viewing the painted walls of an Egyptian temple. These sketches, he said, seemed to be of great age, but over the surface of some of them were drawn in fresher colours smaller and more recent scenes, and rude forms of animals, such as the wallaby, kangaroo, porcupine, crocodile, &c., &c. In one or two places he noticed alphabetical characters, somewhat similar to those seen by Sir George Grey in nearly the same latitude, but many miles westwards on the Glenelg River.

At Buckland's tableland, in Central Queensland, on the banks of Nardoo Creek, is a high cliff, and on its face is a magnificently executed picture representing a lake of fire, out of which are stretched dusky brown arms in hundreds in every conceivable position, the muscles knotted, and the hands grasping convulsively, some pointing a weird finger upwards, others clenched as in the agonies of death, as though a host were engulfed in a seething lake of fire. All these limbs are life-size, and the whole picture is about 70 feet across. Although the hands and arms are little more than outlines, yet so faithful are these from an anatomical point of view that every joint can be seen, and each looks alive. The proportions of the limbs indicate that they are those of blacks, and on some of the hands the fingers are bent backwards, as only little girls and aboriginals can bend them. Near the bottom of this picture feet are represented, mostly men's and women's sizes; there are, however, some that are children's.

In addition, there are representations of boomerangs, nulla-nullas, coolimans, stone tomahawks, and other implements. The groundwork of this grand picture is painted in pigments of red, white, blue, and yellow, giving the general effect of a mass of sulphurous fire. The figures are the natural colour of the rock. Over the top of this pictograph is a projecting ledge varying in width from 4 feet to 6 feet; the under side of this ledge is also painted. It is evidently of high antiquity, as the lowest of the pictures is at least 21 feet above any standing point, and is on the smooth face of a slab of rock, so that any bank or ledge of rock giving foothold must have been disintegrated and washed away since the picture was executed. On a close examination, judging from the peculiar granulated appearance of the groundwork and the absence of hard outline, the work appears to have been done in the way of splash-work, the object to be represented being held flat against the rock, and the pigment blown over it in a spray. The whole surface covered by this painting is above 500 square feet. The natives in the neighbourhood have a horror of this place, and when questioned they declare they can give no information about it; some old white-headed blacks know nothing about it, nor did their fathers, they say. On the same rock there exists some other curious marks, such as emus' feet, snakes, boomerangs, and other things carved in the solid rock with singular precision of detail. On another part are three large figures roughly drawn in red. One appears to represent a man, but he is furnished with a large broad tail; another is a nondescript monster with round body, round head, and four appendages like fins; the third is a well-executed frog of enormous size, about 8 feet long, represented in the act of jumping. These pictures are outlined, and then filled in with shade lines crossing one another, and dividing the figures into small rhomboids.

I am enabled, by the courtesy of my friend Mr. R. Etheridge, junr., the Palæontologist of the Australian Museum, Sydney, to show a copy of the drawing found depicted on the Wollombi rock-shelters (*Plate J*). The group to the left represents probably a drawing of the sun, surrounded by hands and feet, the former being principally the right. One, nearly in the middle line, shows how the operation had been interrupted, and the hand replaced in a slightly different position. The upper right-hand figure represents a shield with an imperfect hand placed across the middle. The right-hand figure is that of a well-formed boomerang. The middle right-hand figure shows a hand probably intended to be holding a tomahawk. The lower right-hand figure shows a group of hands, possibly female.

The following picture (*Plate S*) represents a group of native animals, drawn by a Coorong native, named Yertabrida Solomon; the original is in the possession of the family of the late Rev. Geo. Taplin, at Point McLeay, on Lake Albert.

SCULPTURE AND CARVINGS.

I have before referred to the profile of the human head found by Sir George Grey cut out in the sandstone rock. This rock was so hard, says Sir George, "that to have removed such a large portion of it with no better tool than a knife and hatchet made of stone, such as the Australian natives generally possess, would have been a work of very great labour. The head was 2 feet in length and 16 inches in breadth in the broadest part (*Plate E*); the depth of the profile increased gradually from the edges, where it was nothing, to the centre where it was 1½ inches; the ear was rather badly placed, but otherwise the whole of the work was good, and far superior to what a savage race could be supposed capable of executing. The only proof of antiquity that it bore about it was that all the edges of the cutting were rounded and perfectly smooth, much more so than they could have been from any other cause than long exposure to atmospheric influences." John Stockdale was the first European who drew attention to the sculptures in the neighbourhood of Botany Bay and Port Jackson. Governor Phillip, in his excursions in the vicinity of the abovenamed places, found the figures of animals, shields, weapons, and even men carved upon the rocks. Fish also were represented, and in one place a large lizard was sketched with tolerable accuracy. On the country surrounding Manly Beach they found various figures cut on the smooth surface of some large stones; they consisted chiefly of representations of aborigines in different attitudes, of their canoes, several sorts of fish and animals. Captain

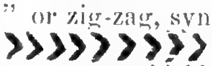
Tench also bears testimony to the delineations of figures of men and birds cut on the rocks at these places. At Middle Head a flat rock was covered with representations of whales, sharks, and other fish; one of the whales was at least 30 feet long. A flat rock on Sydney Common was covered with figures of kangaroos, opossums, fish, boomerangs, and other weapons.

Ideographic rock-carvings, the work of the aborigines, exist near Manly, of which the following descriptions are taken from the "Records of the Geological Surveys of New South Wales, 1890":—1, a large fish 24 feet long; 2, another fish lying at right angles to No. 1; 3, an extraordinary fish, sub-parallel to fig. 2, 16 feet 9 inches in length (within its outline is that of a man); 4, a shield of the usual type; 5, a shield with expanded apices, gathered or puckered together; 6, a rude figure of a kangaroo, seven feet in height; 7, a well-executed figure of a smaller kangaroo; 8, figure of a man; 9, a group of objects in a depression on the sandstone table—a fish (probably a hammer-headed shark) five feet long, a fish with the head marked off by a diagonal line, a fish with a wide gape, and a body (perhaps intended for a flying squirrel).

Captain Stokes, whilst surveying the north-west seaboard in H.M.S. "Beagle," in 1840, in those large and numerous clusters of islands called "Dampier's Archipelago," discovered some carvings on Depuch Island. The group of islands, of which this is one, is so connected with the main by extensive sandbanks, that at low water it is possible to walk across to them. The natives enjoy the pleasure of delineating the various objects that attract their attention—viz., human figures, animals, birds, weapons, and domestic implements (*Plate O*). "1, a goose; 2, a beetle; 3, a fish with a young moon just over it; 4, a native armed with spear and shield; 5, a duck or a gull; 6, a native building a hut; 7, a shark and pilot fish; 8, a corroboree or native dance, a wheel-like object. (During the corroboree the ground is literally beaten hard by the natives, indeed it is so beaten down that the grass cannot spring through it, and it remains for a long time untouched by herbage of any kind.) 9, a native dog; 10, a crab; 11, a kangaroo; and 12 appears to be a bird of prey which has seized upon a kangaroo rat."

The most remarkable of these ideographs is one discovered by Mr. Arthur John Giles at the junction of Sullivan's Creek with the Finke River, in the centre of Australia. This is a smooth-faced rock, portion of a rocky cliff about 45 feet high, composed of hard metamorphic slate (*Plate P*). The lower portion of the sculptured face has been worn and broken away, forming a sort of cave; from the level bank of the creek to the lower edge of the sculptured rock is about 15 feet. The perpendicular lines are cut out, forming semicircular grooves about $1\frac{1}{2}$ inches in diameter, cut in to a depth of nearly $\frac{1}{2}$ inch; all the remaining figures are carved into the solid rock to a depth of about $\frac{1}{4}$ inch. The right-hand portion has been broken away by storms and other causes. The lowest portion is far above flood influence now, and a person could not gain access to it without a ladder. None of the natives can give any information respecting it. It must necessarily have been done at some very remote period of time, as the wearing away of the hard rock to form the large cavity underneath must have taken long years to accomplish; coupled with this is the fact that the sand-bed of the creek has a further depth of 15 feet to 20 feet. The wavy line across the whole represents a crack in the rock, caused doubtless by the lower portion having fallen away, leaving little or no support to the upper structure.

Some of the natives on the Finke River are very ingenious in carving walking-sticks. One in my possession is in the form of a snake, the head forming the knob; the scales are marked down to the ferule; near the head and on the back of the stick is carved a native armed with spear and shield; below him is carved a large cicada; below this a large spider, and twining round the stick is raised a small snake in the spaces between the other objects, but so as not to touch them. The accompanying sketch (*Plate Q*) represents a walking-stick in the possession of the Hon. Sir E. T. Smith, of Adelaide; it represents a hawk whose habitat is said to be on the Finke River. In this carving the bird is shown to have caught a snake by the back of the head, its talons clasping the reptile firmly round the neck in such a position that the snake is powerless to injure the bird. A second and smaller snake is seen to have coiled itself round the body of the larger one in the grasp of the bird. The head of the bird forms the knob, and the snake forms the walking-stick itself. The carving is most beautifully done. Similar walking-sticks are in the possession of His Excellency the Governor (the Earl of Kintore); the Hon. S. J. Way, D.C.L., Chief Justice of South Australia; and of Mr. Craigie, of Adelaide.

It is well known that the aborigines had a system of picture-writing, and of conveying intelligibly to other natives the meaning of messages by means of cuts or marks, and of tribal distinctions by means of cutting or tattooing some particular part of the human frame. The untaught native has produced exactly the same lines, figures, and ornamentation that laid the basis of the artistic designs of the great architects of Europe, Asia, Africa, and America, such forms being in use there at the present day and universally adopted. The "meander" or zig-zag, symbolising water , and the symbol of fire  are found cut on numberless waddies, wommerahs, boomerangs, shields, and bull-roarers. Another marked structural source of ornamental motive may be found in the chequer from the plaiting of rushes and fibre in a net or dilly-bag; it is not difficult in following this clue to trace the evolution of certain well-known types of pattern, all these at the same time falling into and expressing the contours of the implement or vessel they decorate. The idle streaks, cuts, or notches of the knife are not in themselves ornamental; but when arranged into some sort of pattern, they then become the fundamental elements of ornament and design generally. Throughout Australia the natives have conventional forms for trees, lakes, and watercourses, and in some instances so simple as to be in reality symbols rather than diagrams or pictures, and intelligible to all the tribes that look upon them. Their message-sticks were almost always carved or marked either as an aid to the memory of the bearer of the message from one tribe to another, or as actually recording the message itself. We know that they often recorded events which they deemed worthy of being held in remembrance on their throwing-sticks. In Brough Smyth's "Aboriginals of Victoria," vol. 1, p. 355, is the following:—"In June, 1870, an aboriginal named Jacob was condemned in Queensland for a serious crime committed by him, and a plot was laid by some members of his tribe to rescue him. A message-stick, which had been conveyed to Jacob by some means of which the gaol authorities could get no knowledge, was found in his possession, and a native trooper, belonging to another part of the country, gave an interpretation of the symbols as follows:—'Two blackfellows come up in two days; seventeen days ago. One blackfellow come up to where this fellow (Jacob) sit down. The track shown on the stick means from the place where the blackfellows set out to Brisbane.' The message meant that the aboriginals were taking steps to aid Jacob in some attempt to escape." Message-sticks are in use throughout all the country. Mr. Curr relates that "he was once travelling with a black boy, when the latter produced from the lining of his hat a bit of a twig about an inch long, and having three notches cut on it. The native explained that he was a *dhomka*, that the central notch represented himself, and the other notches—one the youth sending the message, the other the girl for whom it was intended. It meant, in the words of Dickens, 'Barkis is willing.' The *dhomka* sewed up the love symbol in the lining of his hat, carried it thus for months without divulging his secret to his sable friends, and finally delivered it in safety to the girl." Their boomerangs and wommerahs were favourite implements for displaying their artistic skill and ability in carving. In Breton's work on New South Wales, published in 1833, is a plate showing some war implements carved in the conventional manner (*Plate R*); examine carefully the boomerang, when you will observe the bust of a man carved thereon.

About seven miles from Mount Douglas head station, in the northern portion of South Australia, is a large native quarry, 150 feet long by 20 feet wide, and 12 feet deep. The stone is a gritty fissile quartzite, eminently suitable, by its lightness and grinding properties, for the nether stone used by the natives whenever they bruise or pound the various leguminous seeds they collect. (The upper stone was generally a large pebble.) The nether stones removed from this quarry slightly varied in size, yet seldom exceeded 18 inches long, 12½ inches across, and 3 inches in thickness. One in my collection is a perfect oval in shape; it weighs 14¼ lb.; is 19½ inches long, 12½ inches across, and 1¼ inches thick; the upper edges being beautifully bevelled off. The stone removed from the Mount Douglas quarry equals 1,333 tons cubical measurement; and as the tribes are few in this part of the continent, and the members of these tribes are in no case numerous, it will be seen that this quarry must have been worked for ages, and must have produced, allowing one-fourth for waste, some 71,000 stones for the use of the natives.

In every part of the continent there are numbers of quarries for ochre, stone tomahawks, stone spear-heads, stone chisels, and stone picks. Wells of peculiar construction, and weirs of immense size, have been sunk or erected by the natives, which show ingenious ability to invent and carry out in detail. Drains for fishing purposes, with weirs at certain intervals, are now in existence in Victoria and South Australia. The sinking of these drains to a depth of 6 and 8 feet, cut in some places through the solid rock, and winding in and out as the contour of the ground required, must have engaged these native navvies a long time, as well as tested their ingenuity and constructive ability. The aboriginal nets and implements for catching fish and birds are models of good workmanship.

Their surgical operations, from the setting of a broken limb to the amputation of one, are operations not to be despised. They have utilised native plants and their extracts for the cure of bodily ailments —for instance, the Goa-Loo-Wurrah (*Sarcostemma australe*) is used in the cure of skin diseases, by breaking off a piece of the plant and applying the milky juice, as it oozes out, to the sore by touching it all over in a similar way to the application of caustic. Goa-Loo (*Alstonia verticellosa*), the bark of the milk tree, is applied to cuts and wounds. The Gue-Way-Lah is a kind of gum extracted from a species of Eucalyptus, which is used as a plaster for wounds and old sores.

In many parts of the country their cemeteries are kept with loving care, and show much taste and ability in laying them out. *Plate T* represents a burial-place called "Milmeridien," near the Bogan River. Sir Thomas Mitchell says -It was a fairy-like spot in the midst of drooping acacias. It was extensive, and laid out in walks, which were narrow and smooth, as if intended for spirits only, and they meandered in gracefully-curved lines among the heaps of reddish earth, which contrasted finely with the acacias and dark casuarinas around; others gilt with moss shot far into the recesses of the bush, where slight traces of still more ancient graves proved the antiquity of these simple but touching records of humanity." A similar cemetery exists near the Finke River, in the centre of the continent.

Plate U represents a tomb discovered by John Oxley in 1817 in 146° E. and 33° S. He came upon a tumulus apparently of recent construction, and from the exterior marks he imagined that some person of distinction had been buried there. The form was semi-circular, and three rows of seats occupied one-half the grave, and an outer row of seats the other. The seats formed segments of circles of 50 feet, 45 feet, and 40 feet each, and were formed by the soil trenched up from between them. The centre part of the grave was about 5 feet high and about 9 feet long, forming an oblong pointed cone.

In long. 125° 11′ E. and lat. 16° 1′ 45″ S. Captain Grey found two remarkable heaps of stones. The southernmost one was opened by him. He states that "five men were occupied two hours in opening from the side to the centre, and thence downwards to the middle. The stones were of all sizes, from one as weighty as a strong man could lift to the smallest pebble. The base of each heap was covered with rank vegetation, but the top was clear from the stones having been recently deposited. These heaps were placed due east and west, and, as will be seen, with great regularity." (*Plate V.*)

MUSICAL INSTRUMENTS.

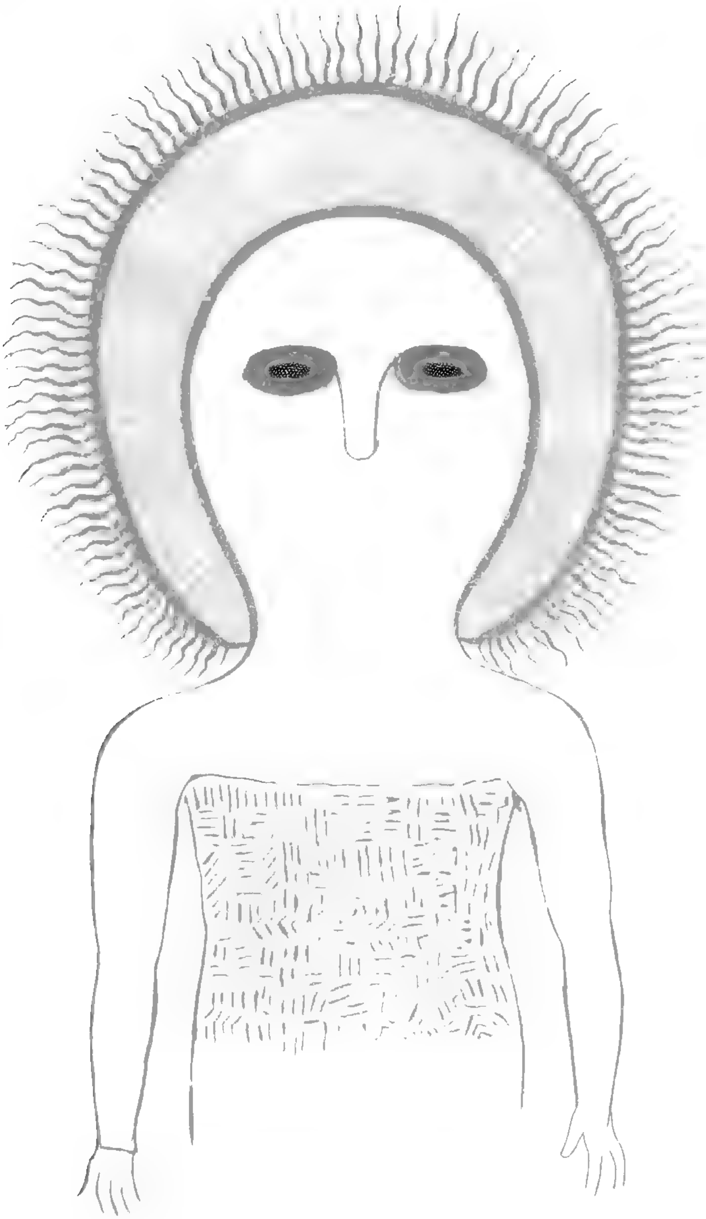
The Australian natives are very poor in respect to instrumental music. Their usual and universal accompaniments to their songs and dances are the rolled-up opossum rugs beaten like drums with the hands, and the clash of two sonorous pieces of wood, keeping time with the song. There is, however, another instrument called the *Eberoo*, or *Ebroo*, being a long and hollow bamboo. One of these native trumpets in my possession is 4 feet 5 inches in length; the diameter of the mouthpiece (if I may so call the mouth end) is $1\frac{1}{4}$ inches, and that of the outer end is $1\frac{3}{4}$ inches. The mouthpiece is the natural colour of the wood, though darkened by constant use from the hands and lips; the other portions are painted in sections, red and white alternately, with, along the whole length, incisions made with some sharp instrument in this form ∧∧∧∧∧∧∧. Where the bamboo has split, the openings have been filled with gum. A monotonous sound is produced by the breath of the performer. A species of Sistrum is in use (*Plate W*) about 100 miles inland from Port Douglas and Cairns, on the north-east coast of Queensland, consisting of seven shells strung on string, and suspended from a vertebra of a dog. The apices have been completely ground off, leaving only two body whorls, and these have been transversely cut through. The string, which is two-ply, and made of fibre dyed brown, is passed through the hollow body whorls of the shells and out through each slit on the backs. The two parts are brought together and knotted so as to form a loop. One of the free ends is then put through the neural canal of the vertebra and tied. In two of the shells the string passes through the slits, and not vertically down the body of the whorl at all. The jingle caused by shaking the shells is pleasant and melodious, the vertebra being held in the hand. I am indebted to my friend Mr. R. Etheridge, the Palæontologist of the Australian Museum at Sydney, for this description of the Australian Sistrum.

CONCLUSION.

The art and skill with which some of the figures are drawn, and the great effect which has been produced by such simple means, render it most probable that many of them must have been executed with the intention of exercising an influence upon the fears and superstitious feelings of the ignorant and barbarous natives; for such a purpose they are, indeed, well calculated. I have no doubt that were this subject followed up by intelligent explorers and others, who may be brought into contact with examples of native art, much profit and great pleasure would be derived from their reproduction and publication. A family likeness marks all of them; the details are everywhere the same; no variations show themselves. All are imitative, and are the resultant product of untutored taste, although diligent research may bring to light other illustrations of the awakening consciousness of the savage, who may have tried in carving, sculpture, or in painting to express the artistic tastes he felt working within him. Australia contains a secret that may possibly be discovered if the symbolic character found in numerous places can be interpreted. Until this is determined, and what is now unintelligible made clear, all conclusions, in default of other evidence, must necessarily be conjectural.

In respect to the quarries and the wells, and the patient toil they have entailed in their working, I must conclude that when one witnesses the slow progress made by good workmen, aided by steel and the most modern explosives, and when one calls to mind the fact that the natives had no better tools than they could fashion out of wood or stone, the realisation of the vast amount of labour involved in these excavations strikes one with amazement.

A

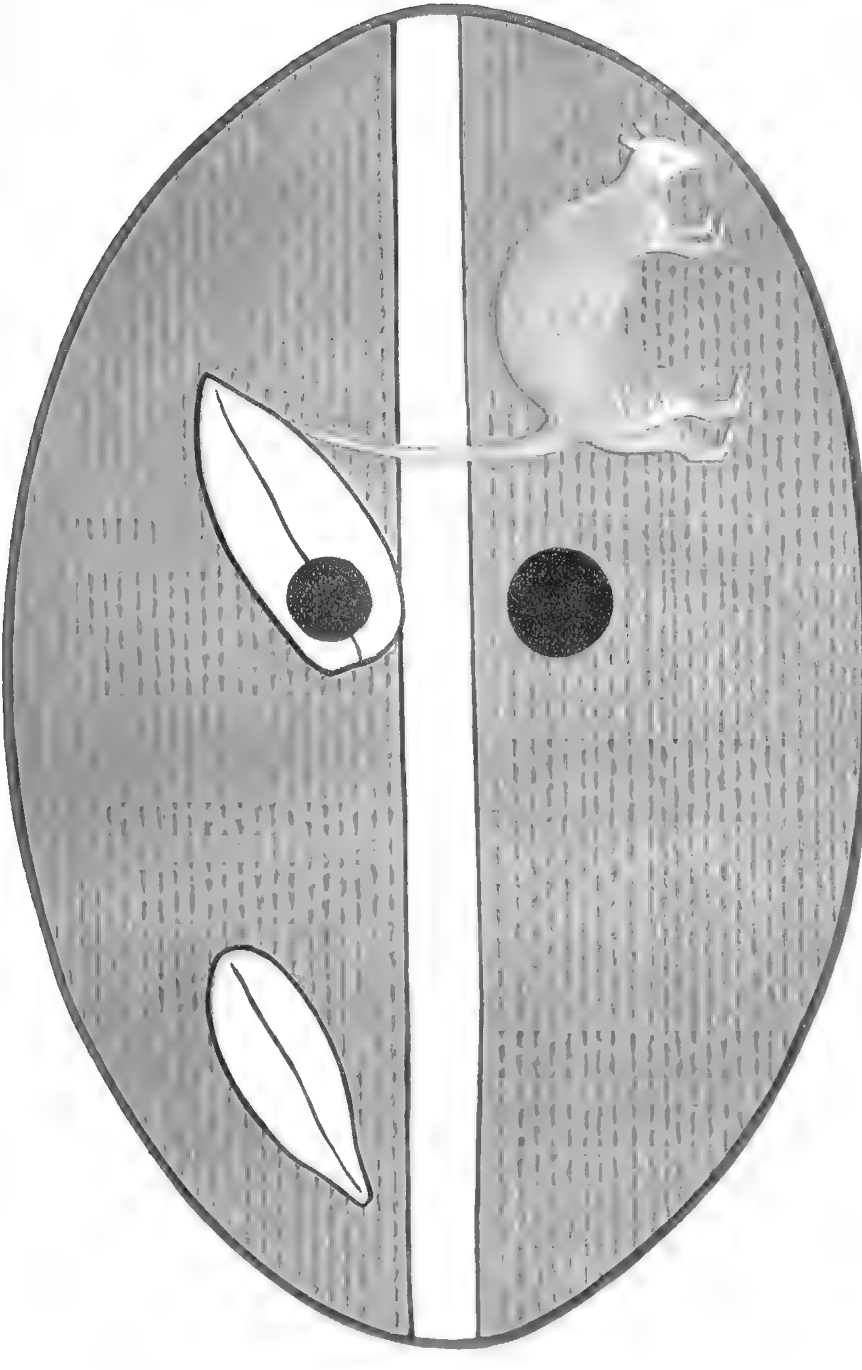


From Grey's Expeditions in Australia

B

From Grey's Expeditions in Australia

C



From Grey's Expeditions in Australia

W

Plate VII.

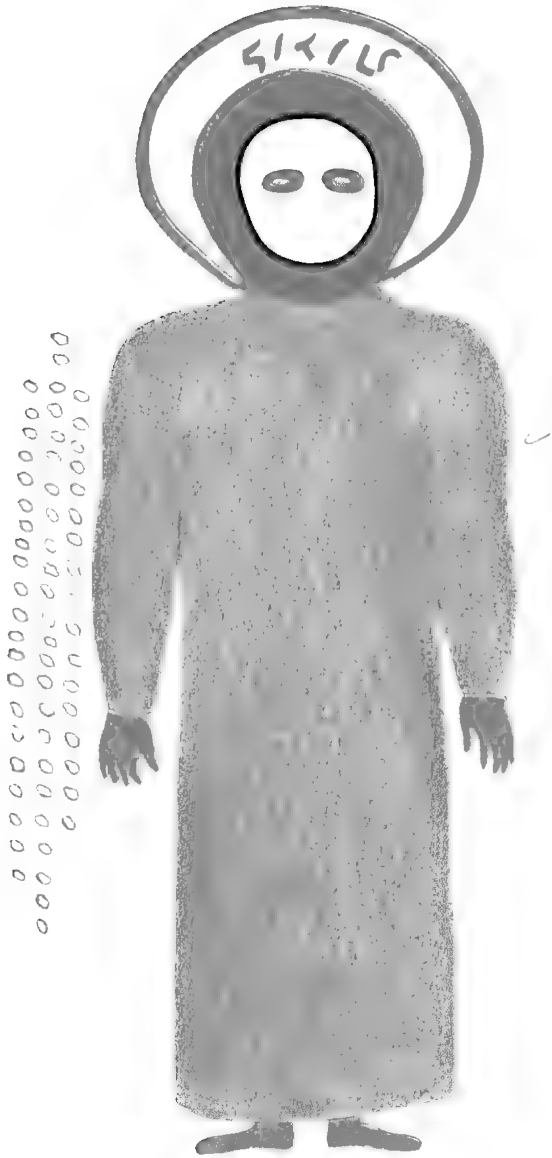
D

From Grey's Expeditions in Australia

E

From Grey's Expeditions in Australia

F



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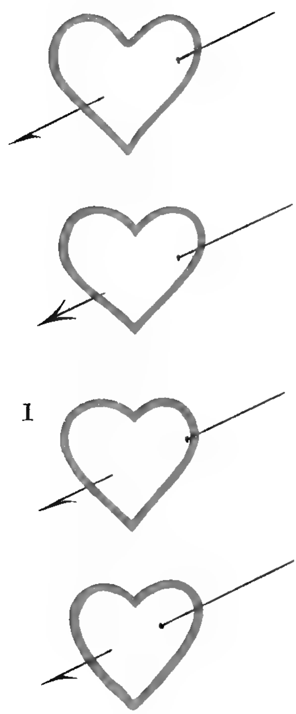
G



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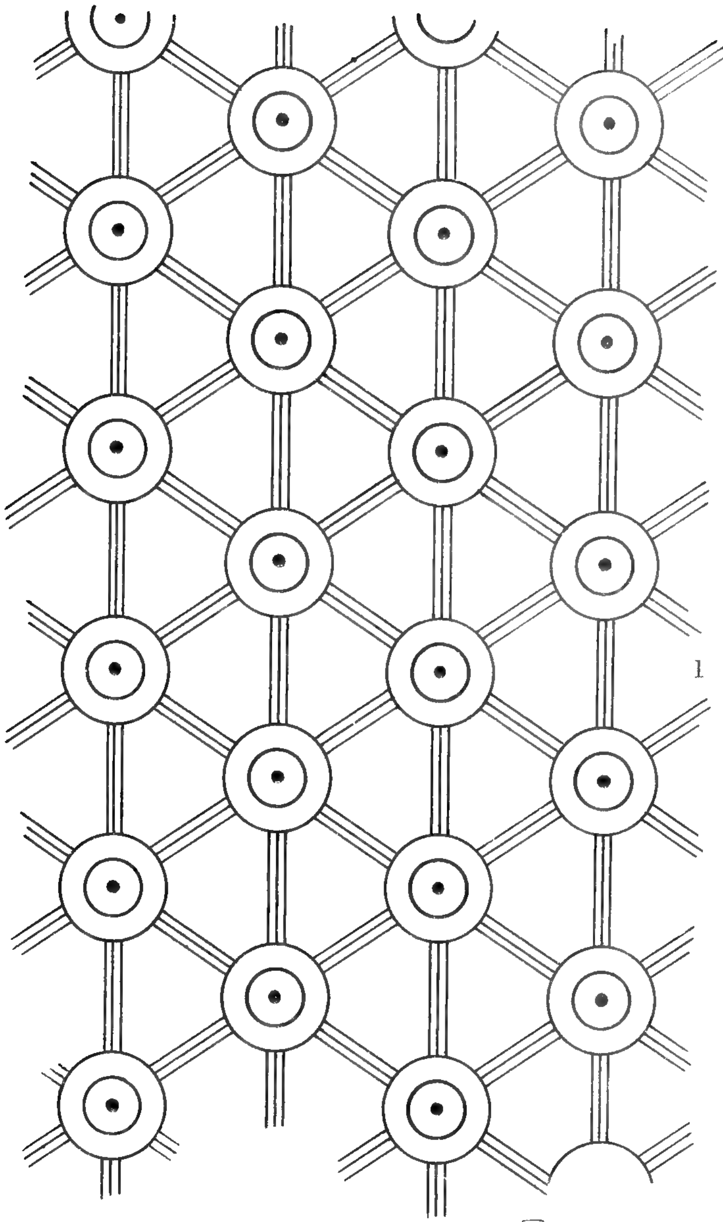

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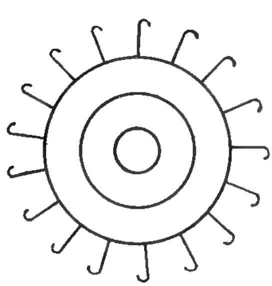

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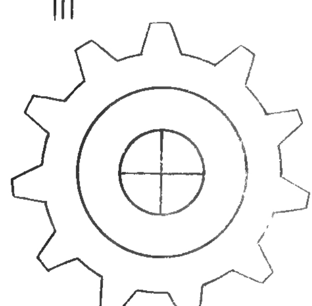

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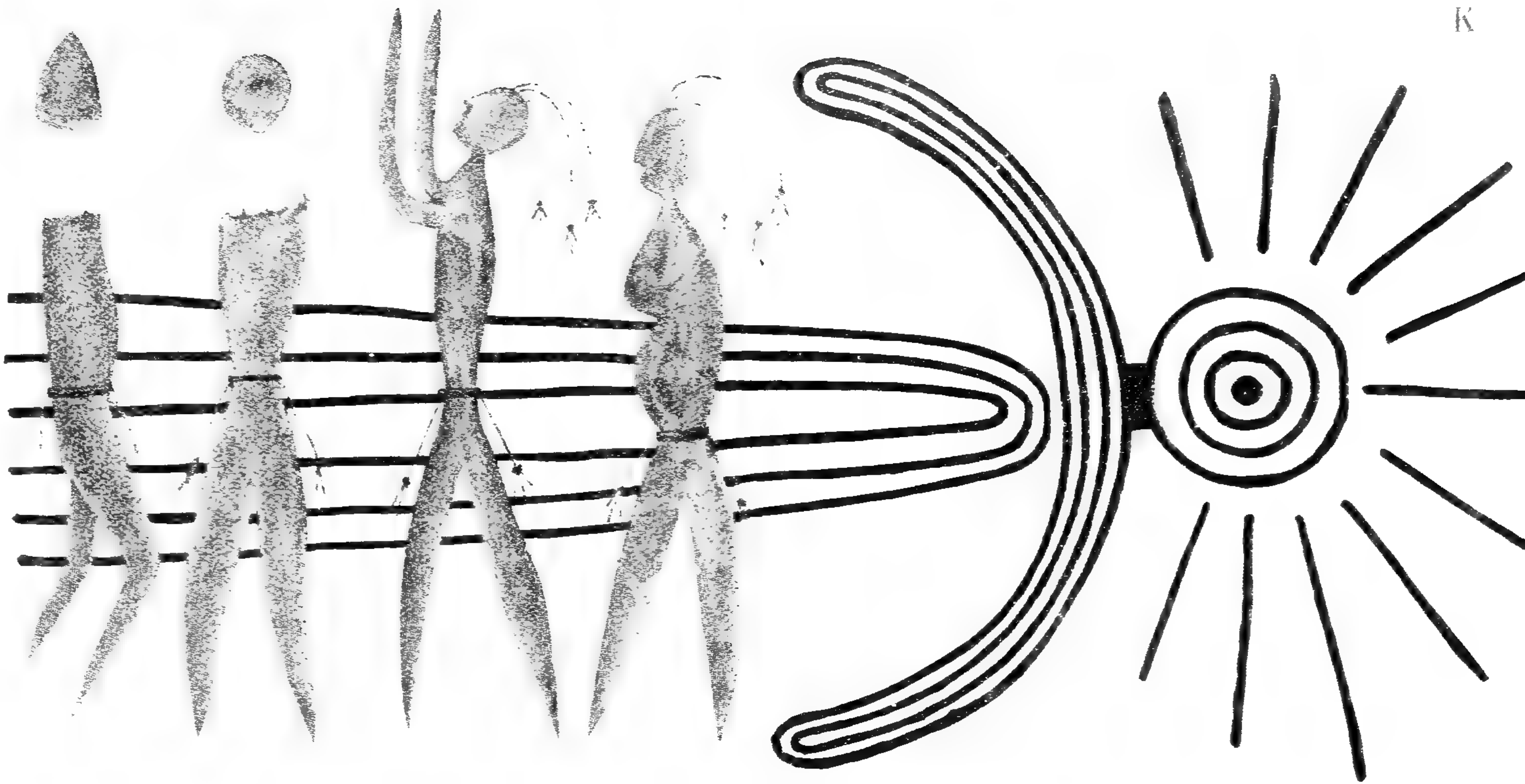
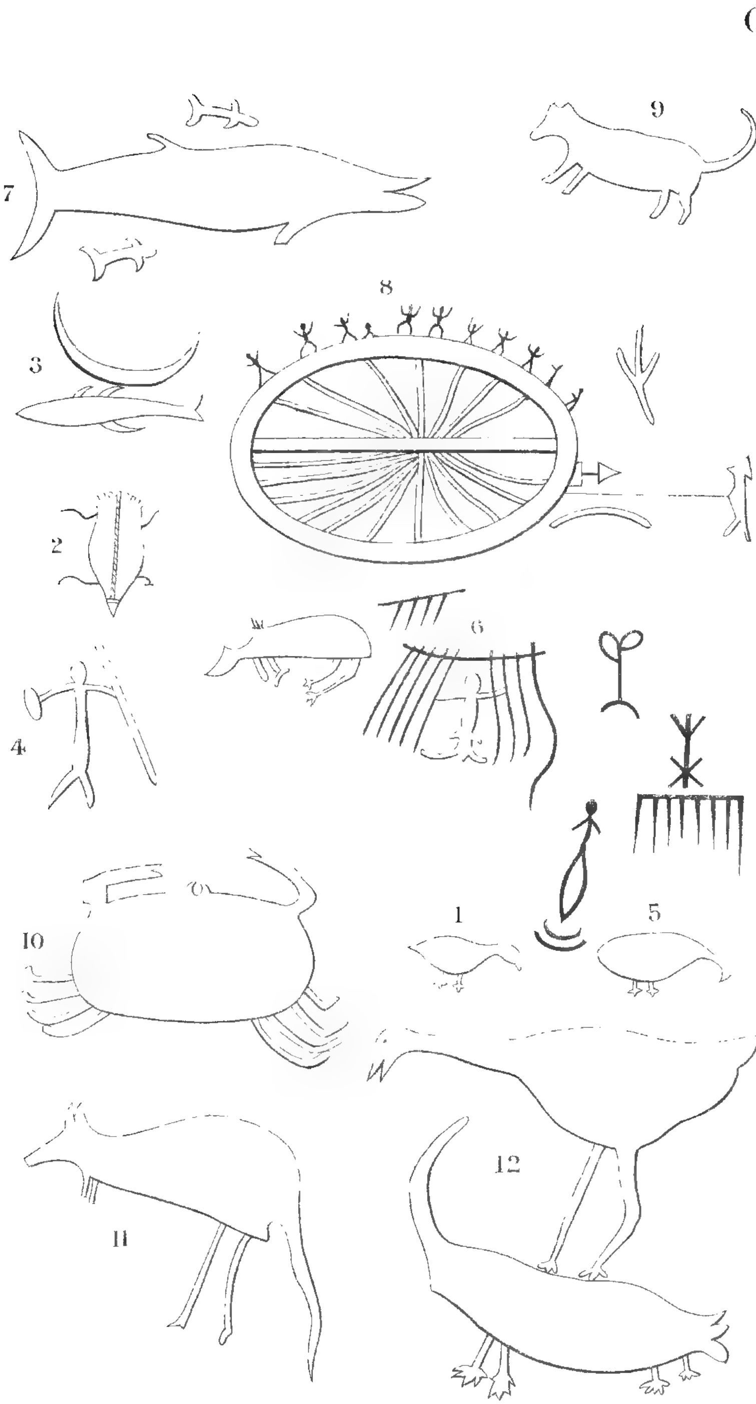


Native paintings on the Fitzroy River

Native paintings on the Fitzroy River.

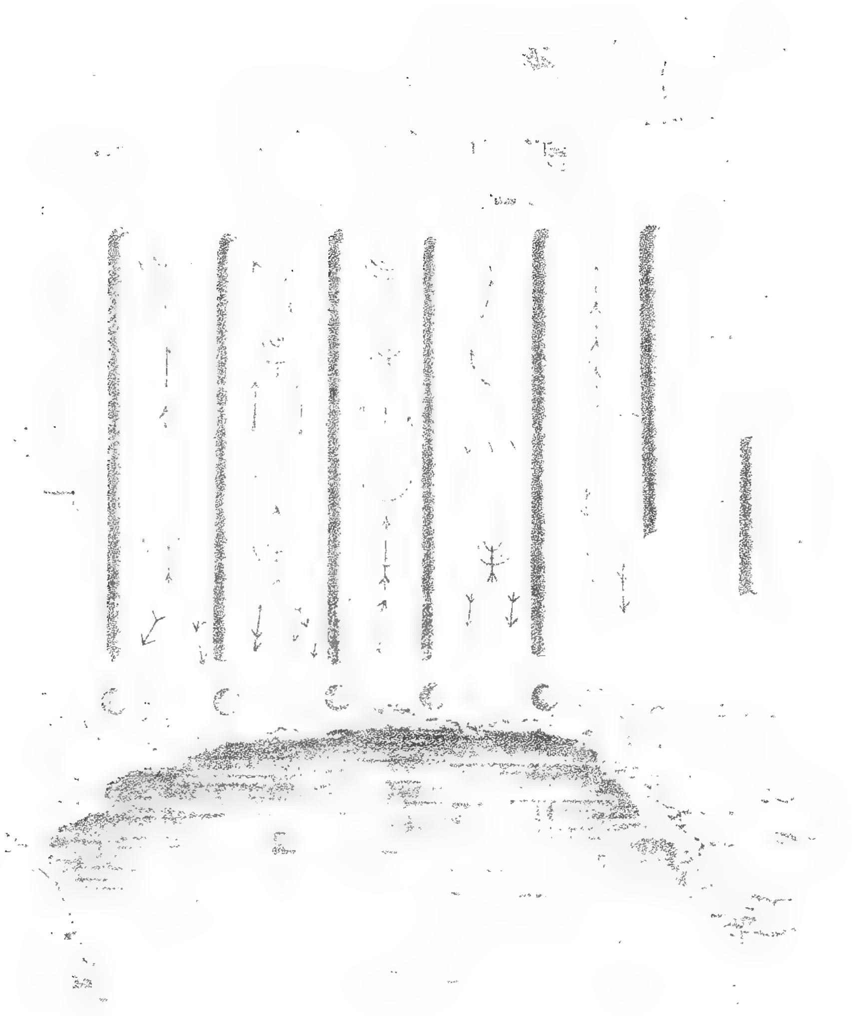
Plate XVI.

Native paintings on the Fitzroy River (Bradshaw



From Stokes' Voyage of H.M.S "Beagle"

P



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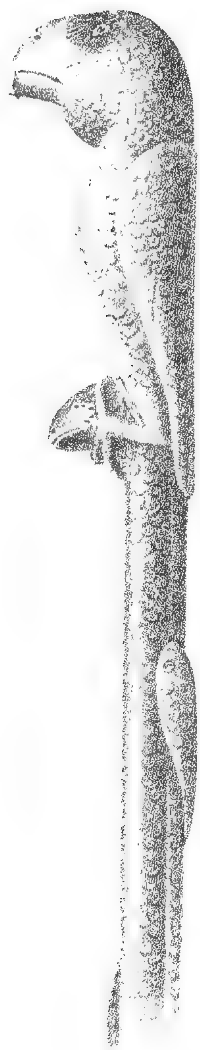

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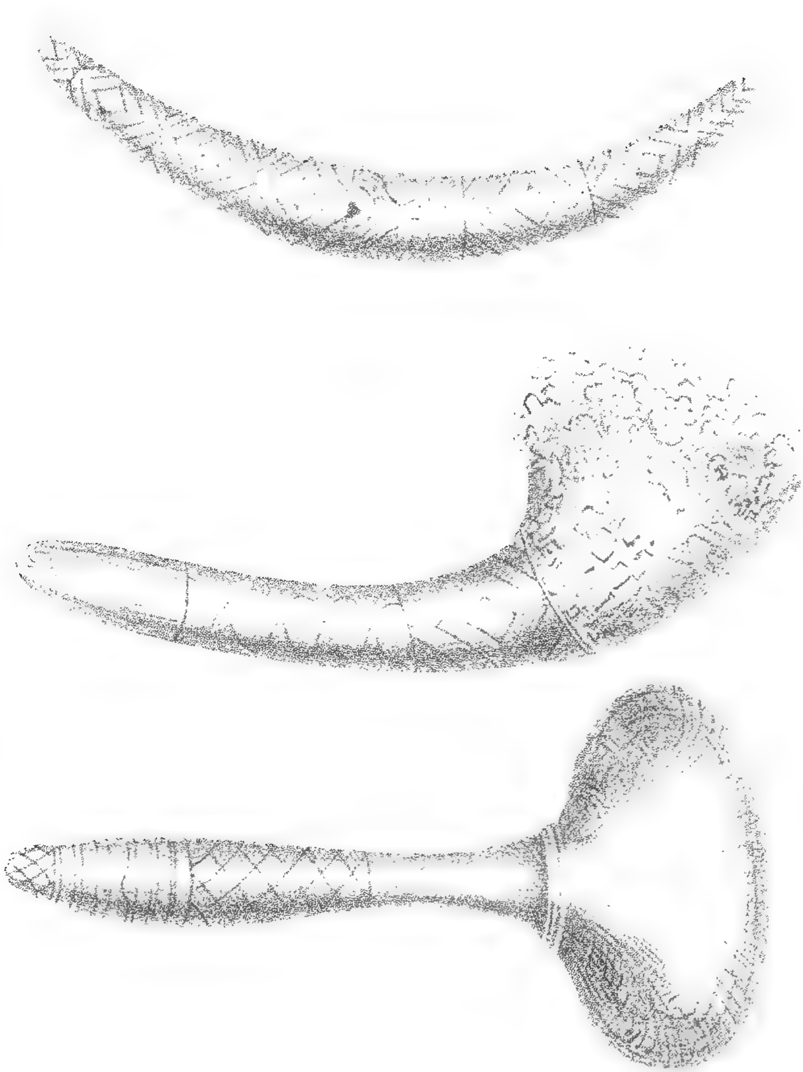
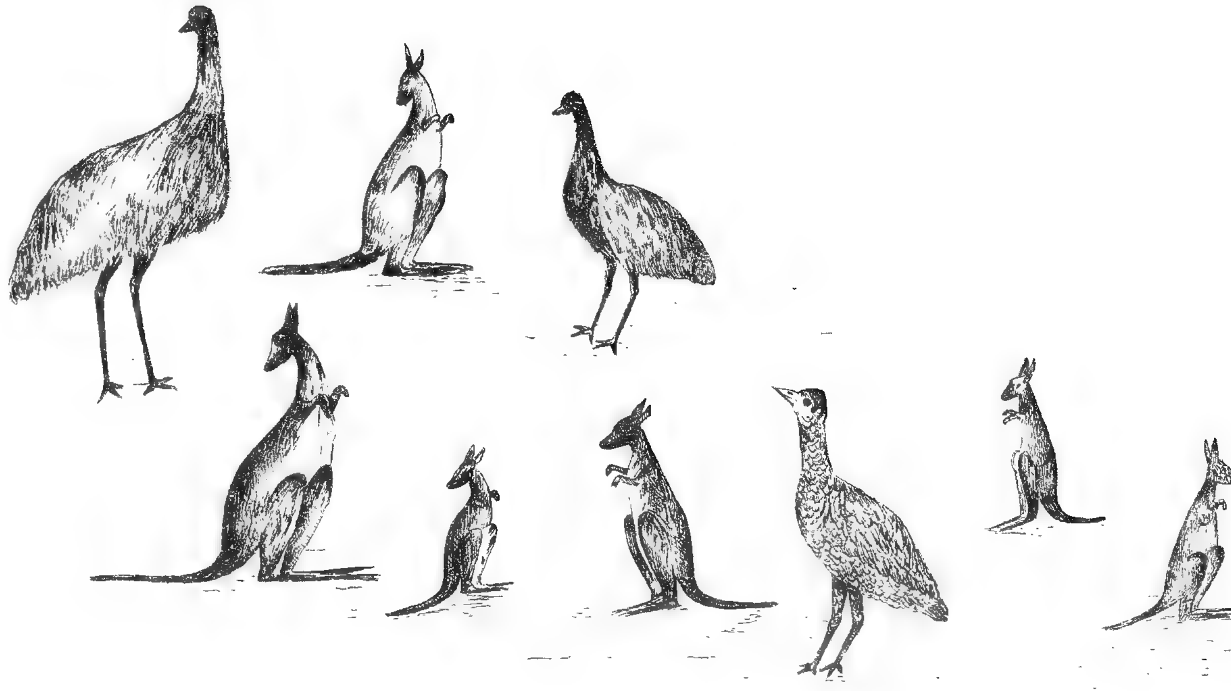


From Breton's "New South Wales."

S

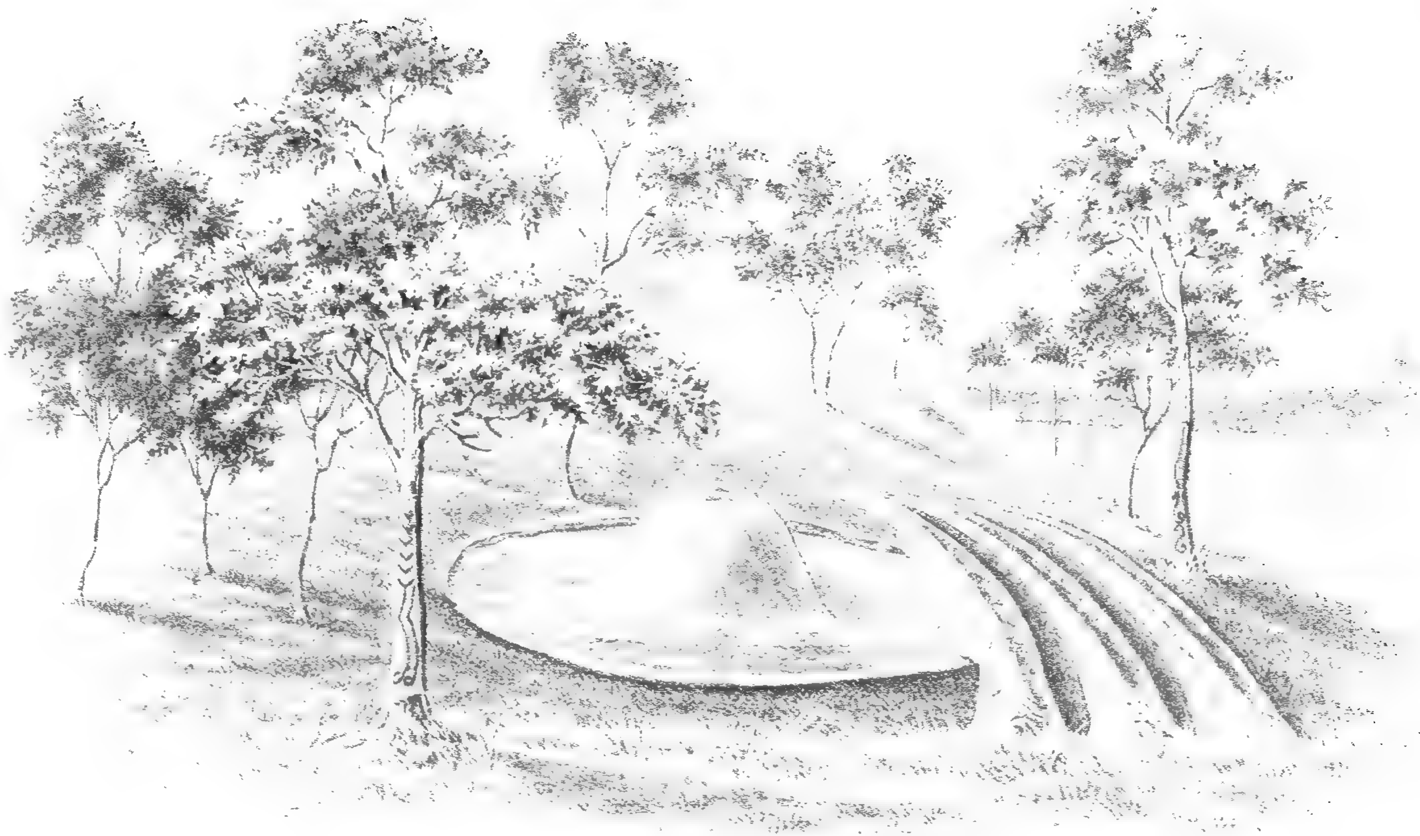


Nº 8. Group of Animals.

Drawing by "Yertabrida Solomon" an Aboriginal of the Coorong, in 1876. (From original in possession of Rev Geo Taplin.)

Plate XXIII.

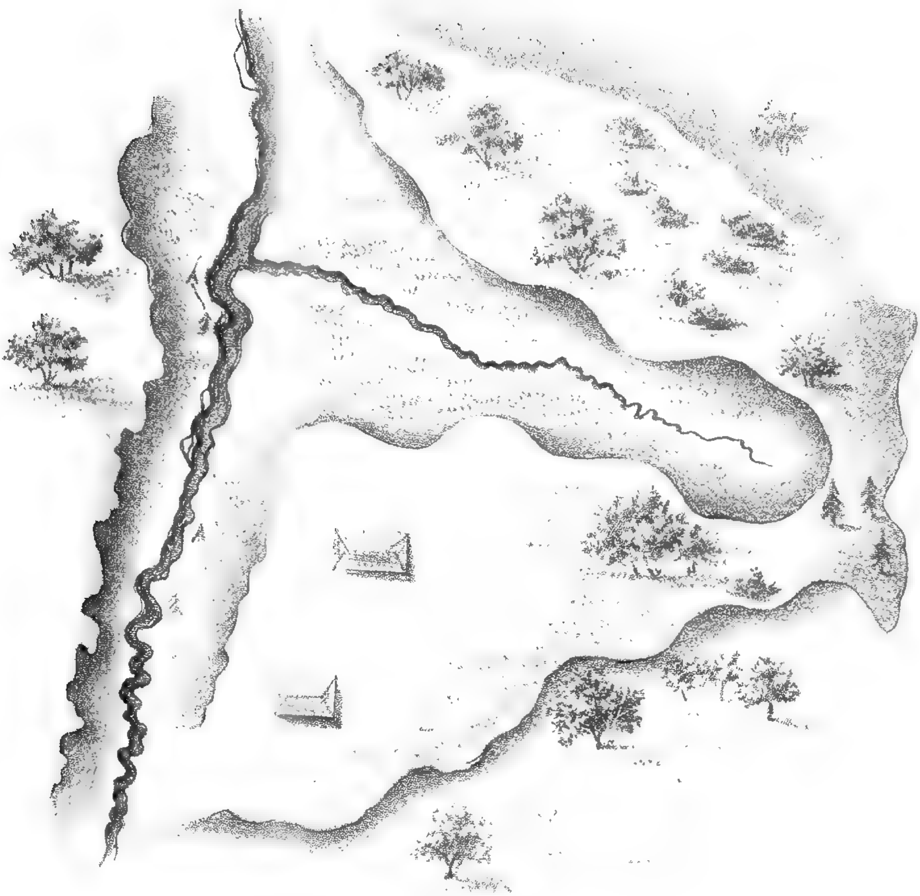
Burying Ground at Milmeridien



A Grave of a Native of Australia

V

N.W. COAST OF NEW HOLLAND
7th April 1838.



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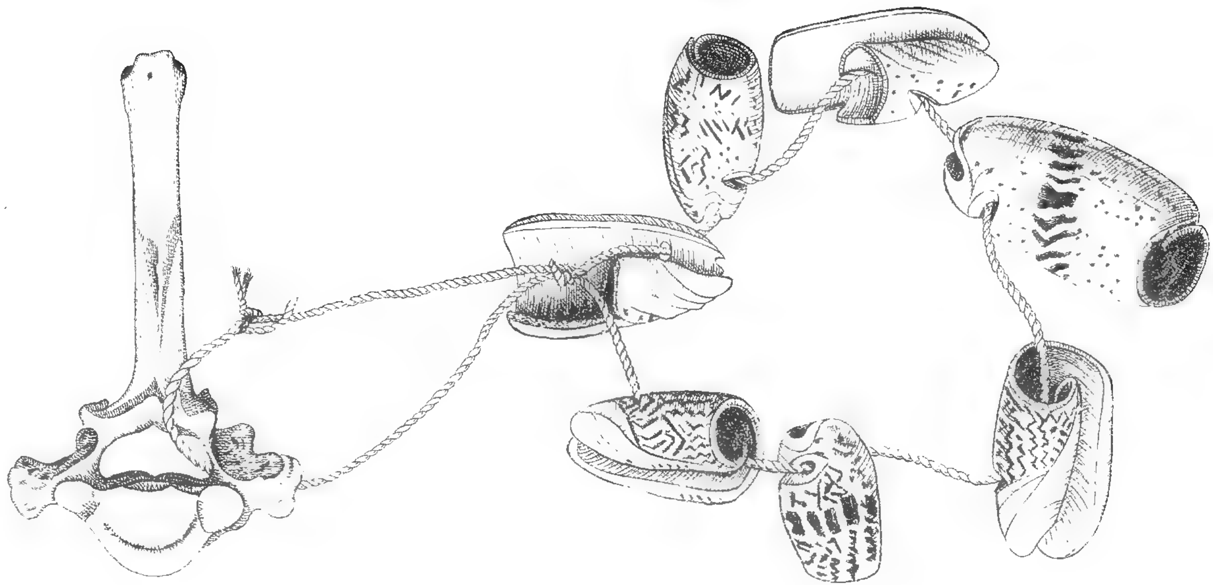

Musical Instrument.

Section G.

ECONOMIC SCIENCE AND AGRICULTURE.

ADDRESS BY THE PRESIDENT,

PROFESSOR W. SCOTT, M.A.

ON FIXING A MINIMUM WAGE.

I have first to express my regret that the chair of this section is not occupied, as was at first arranged, by His Honour Chief Justice Way. As he has been detained by duties of another kind, we are deprived of the privilege of hearing an address from him; and I have somewhat reluctantly accepted the invitation of the committee to take the place which he would have more worthily filled.

The subject on which I propose to speak is one of which we have heard something lately in the region of practical politics, and are likely to hear more—the question of fixing a minimum wage. What guidance has economic science to give upon this matter?

The earlier economists, when they sought to bring their theory to bear on practical politics, were, I suppose, aiming at ends essentially the same as those which most of us still think desirable, and had in view the promotion of the most satisfactory human life. But, looking at the industrial world mainly (though not entirely) from the point of view of the "business man," they answered the question "What is it best to do?" (with some limitations and exceptions, which their careless critics often omit to notice) by the general solution "*laissez faire.*" Let Government, they said, restrict itself to the task of preventing any man from taking goods or services from any other man without that other's consent, and give him all possible facilities for taking them on any terms to which that other *does* consent—in other words, let the prices of all goods and services be settled by free bargaining; and the result will be the best attainable.

This view was stated in impressive words by Goldwin Smith, in an inaugural lecture delivered at Oxford some thirty-five years ago.

"The laws of the production and distribution of wealth," he says —meaning the laws of those processes as carried on by free bargaining—"are not the laws of duty and affection; but they are the most beautiful and wonderful of the natural laws of God. * * Silently, surely, without any man's taking thought, *if human folly will only refrain from hindering them*, they gather, store, dispense, husband, if need be, against scarcity, the wealth of the great community of nations. They take from the consumer * * the wages of the producer, * * his just wages; and they distribute those wages among the thousand or hundred thousand workmen who have contributed to the production, justly, to 'the estimation of a hair,' to the estimation of a fineness far surpassing human thought. * * To buy in the cheapest and sell in the dearest market, the supposed concentration of human selfishness, is simply to fulfil the command of the Creator, who provides for all the wants of His creatures through each other's help; to take from those who have abundance, and to carry to those who have need."

Now, it is a striking indication of the rapid advance of our science, that those words, spoken within our own memory as the deliberate utterance of a "man of light and leading" expressing the best thought of his time, would now serve only to raise a smile in any intelligent audience; and indeed we have to-day, perhaps, more reason to be on our guard against accepting opposite exaggerations, and overlooking such relative and partial truth as those words contain. We know now that the problem is more complicated than it seemed then; that the answer to the question, whether interference with free contract and free competition will yield a balance of good or harm, varies according to circumstances; and that each case must be considered on its own merits. Tell the economist that you propose to check or modify free bargaining for this or that particular group of people, here and now, in this or that particular way, and he may be able to conclude that certain results will probably follow. But his theory contains no rule that will cover all cases alike.

Whatever may be our notion of an ideally perfect distribution, I suppose we shall all be agreed that some workers at present get lower wages than it is desirable that they should get; that it would be better if, of the total satisfaction of human wants produced by human efforts, those workers got a larger share and someone else a smaller. This is true, at least, wherever wages fall below the "necessaries for efficiency"; and that is certainly the case with the wages of some groups of workers, even in this favoured country.

Here, then, are certain cases in which the result of settling the rate of exchange by free bargaining is unsatisfactory. Can anything be done to mitigate the evil? If so, what, and by whom?

There is, I think, only one remedy that would be entirely and finally satisfactory. If the rearing and education, physical, mental, and moral, of those groups of workers who get the lowest wages now could be improved—if they could be so far raised in character and trained intelligence as to become capable of doing more to satisfy the wants of their neighbours, they could then demand and get higher wages for themselves. Increase the average efficiency of all workers, and there will be a larger total of want-satisfaction produced to divide among them; diminish the proportion of the population that are only capable of doing unskilled work, and then those who still do such work would be able, by free bargaining, to get a larger share of the total. But how to bring about this general raising of character and ability? That, for the economist and the politician alike, is the central and all-important question; and it is a question to which no one can give more than the merest fragment of an answer. But this, at least, is clear, that such a rise is almost impossible for any class of workers who now get very low wages; for though a large income by no means ensures a good training for life and work, extreme poverty is in itself a bad training. Such workers are poor because they are inefficient, and are inefficient because they are poor, and because their parents have been poor.

It would seem therefore that if this class is to be raised to a higher level, the *first* step in that direction (though by no means the only step) must be the raising of their present low wages, that being a condition without which a satisfactory life for themselves, and, still more, a good education for their children, is almost impossible.

But, on the other hand, is it possible to raise the wages while the wage-earners remain such as their circumstances have made them? If free bargaining is for this purpose to be set aside, how is that to be done, and who is to do it?

Such action must be taken, if at all, either by individuals (private employers, for instance), or by voluntary associations (such as trade unions, and associations of employers), or by Government.

Now, the private employer is clearly incapable of remedying the evil by his individual and separate action. Even assuming the most hearty good-will on his part, he cannot pay more than the highest wage compatible with carrying on his business, and getting at least a bare living for himself; and that wage may still be less than it is desirable that the wage-earner should receive. For the employer has to lower the selling price of his produce till he finds buyers in the market; and if competition keeps that price low, his choice may be only between paying low wages and paying none at all.

As to the action of voluntary associations—of trade unions especially, and the substitution of collective for individual bargaining at which they aim – there is much to be said; but I must pass on now to discuss possible action of *Governments* in raising low wages.

There are three ways in which a Government can act on wages and conditions of work. First, as a direct employer of workers; secondly, as an indirect employer, through contractors; and thirdly, by regulations controlling private employments.

As to the first point, it is in the power of a Government to fix the wages of its employees either at or above the rate at which competition would settle them. Which is best? That a Government should pay its workmen at the lowest rate at which it can get them, or that it should pay something more?

In the Australian colonies the principle is, I think, generally accepted, that Government should not beat down its employees, at least in the lower-paid employments, to the lowest rate at which workers can be got. Government should, it is argued, be the model employer. Since it has all the wealth of the country to fall back upon, it is not, like a private firm, in danger of ruin if it deals liberally with those in its employment; and it should set an example which may have some influence on private employers also.

But at what point should the minimum be fixed? If we had only to consider the interest of the particular wage-earners immediately concerned, nothing more would be needed than to decide what is the most satisfactory income for a man to receive—whether £500 a year or £5,000 a year—and fix it at that.

But we are limited by the obvious fact that, in increasing the incomes of these persons, we are diminishing by the same amount the incomes of others. The loss must fall on someone; but on whom?

For instance, the Government of New South Wales pays a standard wage of 7s. a day to road-makers, when it could, perhaps, get labourers enough to do the work at 5s. a day. Who has to bear the extra cost?

A Government adopting this policy may meet the cost in either of two ways. First, it may leave its revenue unaltered, and abstain from some works which it would otherwise have funds to carry out. Or, secondly, the Government may increase its revenue by additional taxation.

If it takes the first course, it is the general public that is the loser, being deprived of certain services which Government could otherwise render. A judicious Government will, in that case, cut off that part of its present expenditure which is least useful to the public; and it is for us as citizens to decide whether the gain is worth the cost. We are free to do what we like with our own revenue; we provide ourselves through our Governments with many things which are not absolute necessaries; and if we think it worth while, we can do without some of these, in order to raise the wages of some Government employees which we may consider unduly low. Suppose, for instance, that the choice is between decorating a public office with statues of eminent statesmen on the one hand, and adding 1s. a day to the wages of certain labourers in Government employment on the other hand. If we choose the latter, we shall have fewer statues to feast our eyes on, and we shall have, as a set-off against this, the satisfaction of knowing that certain people employed in our service are enabled to get better food and housing, and that those of them who spend their raised wages wisely are probably bringing up their children to be better workers and better citizens. Well, if the choice is between more stone images on the one hand, and more good workmen and good citizens on the other, there is nothing absurd in choosing the latter; and there is certainly no "law of political economy" to prevent our taking that course if we prefer it.

On the other hand, the Government may decide to do as much work for the public as before, and to raise the necessary fund by additional taxation. In that case, supposing that the taxation can be so adjusted as to fall on those best able to bear it, the result may be a better distribution of want-satisfaction; the rich taxpayer will have to do without a few big dinners or other superfluities, while the Government labourer will be better provided with "the necessaries for efficiency"; and that again is a result which all concerned, the rich taxpayer included, may well consider satisfactory.

But it is sometimes objected that to take this course would be to do an injury to other workers, whose needs may be equal or greater. The argument of the objector, shortly stated, amounts to this: If the governing body spends part of its present revenue in raising the wages of some of its employees, it will have so much less to spend in employing others, and those others will suffer. If, on the other hand, it raises the money to pay the extra wages by taxation, the taxpayers in turn will have less to spend in employing workers, and those whom they would otherwise have employed will suffer. In either case alike, it is maintained, a diminution of employment will result.

This argument is urged, for instance, in a paper by Sir T. Farrer, published in the report of the English Commission on Labour of 1893. The London County Council had established a minimum wage of 6d. an hour for the labourers in its employment; and Sir T. Farrer maintains that to do this is to alter for the worse the condition of other workers, by diminishing the fund from which their wages are drawn, and thus compelling them either to remain unemployed, or to take employment at lower wages.

But this is a mistake. Those who so argue forget that the labourers whose wages are raised will have more to spend, and will give more employment in spending it, by just the same amount that the Government or the taxpayers have less left to spend, and give less employment.

It is true that the quarrymen and stone-workers who supply the statues to the Government, or the cooks and waiters who supply big dinners to the rich taxpayer, will lose opportunities of profitable employment. This the objector sees; but what he fails to see is the compensating fact that those who supply the additional demand of the labourers whose wages are raised will have more employment to the same extent. What the stone-workers and waiters lose, other workers will gain; and, on the whole, there need be no diminution of employment. The change, like any other change of demand, if large and sudden, may cause some temporary distress in certain quarters; but it will be only a *change* of demand, and not a diminution of it, and will ultimately result merely in a changed application of labour-power. When the effects have had time to work themselves out, there will be fewer workers employed in supplying the wants of the public or the rich taxpayer, and as many more employed in supplying the wants of the Government employees. In some cases, indeed, the very same workers may still go on producing the very same goods, the only difference being that these goods will now be bought by A, the Government labourer, out of his raised wages, instead of by B, the taxpayer; and even if the goods demanded by A are of a different kind, they will be of equal value to those which B has ceased to buy, and will give an equal amount of employment in the making.

The effect on employment will, in fact, be the same as if the Government or the taxpayers were to spend part of their respective incomes in directly paying people to render certain additional services to certain Government employees, instead of paying an equal number of people to render services to the public collectively or to the taxpayers individually.

The Government is, in this respect, in the same position as a private employer. If I make a present of money to a friend, I am not thereby "diminishing employment," but only transferring from myself to him a certain power to employ others, or buy services from them; and this is equally true if I add certain shillings to the lowest wages at which I can get a man to work for me. I shall have so much less to spend on other things, and he will have so much more; and whether that is good or bad depends, I suppose, on the question whether he or I spend the money more usefully whether, that is, he or I, by means of it, set workers to do work that is better worth doing. But work or services of some sort or other this money will certainly be used to buy, whichever of us has the spending of it.

It would save us from many such mistakes if we kept in view the fact that the fund out of which the wants of all are supplied is the total produce of all labour—in other words, the total of all services rendered. To assign a larger share of this total to certain people, of course, means assigning a smaller share to others; there is no getting out of that. And in this case the "others" who have to give up part of their share are either the general public as served by Government, or else the taxpayers. But there the loss ends. It is not by paying higher for the services which others render to him that a man diminishes the "fund" of total want-satisfaction; for, in so doing, he is only transferring from himself to others a certain claim upon that total. It is only by "consuming" more himself—that is, by claiming more services from others, and directing to the satisfaction of his own wants a larger share of the total labour-power—that he will diminish the share left to others.

If, then, we come to the conclusion that an addition to the comforts and conveniences of certain Government labourers is the best purpose to which a certain amount of the total labour-power at our command can be directed, we need not be deterred from acting on our opinion by any fear that the total amount of employment for workers will be thereby diminished. It is for our Ministers and Parliaments, and ultimately for ourselves as citizens and voters, to decide whether any change in that direction would be a change for the better; and in any case in which Government employees get very low wages when the rates are left to be settled by competition, there are strong reasons for holding that the change *will* be for the better.

We come next to the case of Government contracts. Contractors who undertake public works may in some cases, when the rate of pay is left to be settled by free bargaining, pay lower wages to their workmen than we think desirable. If this takes place, what can Government do to prevent it? And if it is prevented, at whose cost will the higher wages be paid?

It is possible to insert in the terms of every contract a stipulation that the wages paid shall not fall below a certain minimum. This not only can be done, but in some cases is done. The London County Council, for instance, resolved in 1889 "that the Council shall require from any person or firm tendering for any contract with the Council a declaration that they pay such rates of wages and observe such hours of labour as are *generally accepted as fair in their trade*, and that in the event of any charges to the contrary being established against them, their tender shall not be accepted."

It was found, however, that this clause raised so many doubts and questions that good and careful contractors were unwilling to tender; and partly for this reason, the Council in 1892 substituted the following resolution:—

"That all contractors be compelled to sign a declaration that they pay the *trade union rates of wages*, and observe the hours of labour and conditions *recognised by the trade unions* in the place or places where the contract is executed."

The example has been widely followed in England. It is stated in "Webb's History of Trade Unions" that "a hundred and fifty local authorities have now [in 1894] adopted some kind of 'fair wages' regulation."

In New South Wales, the Department of Public Works has recently taken a similar course. In a minute issued by the Minister in 1894 it is ordered, "with the view of preventing the objectionable practice known as 'sweating' in Government contracts," that "in future in all contracts for works [above a certain sum] it may be provided that the contractor shall pay each tradesman and labourer he employs at a rate of wages not less than *that current at the time of tendering*, such current rate of wages to be *that paid for the same description of work by the best employers* in the city or town nearest to the work tendered for."

Accordingly, a schedule of minimum wages has been drawn up for insertion in all contracts under the Department, subject to alteration from time to time. Where work is sublet, the sub-contractor is to be bound by the same conditions.

Now, what effect is to be expected from this policy? In the first place it is to be observed that the method of fixing the minimum wages is different in the two cases. The London County Council leaves it to the trades unions to fix the rates (a proposed amendment that the rates and conditions should be *those agreed on for the time being between employers and trade unions* was rejected by the Council). The New South Wales Department of Public Works, on the other hand, adopts the rates found to be paid in practice "by the best employers." Of the two, the latter is surely the better course. There is much force in the objection urged by Sir T. Farrer against the former, that the Council, by adopting it, has delegated the important task of fixing the minimum to certain private corporations, the interests of whose members may not coincide with those of the community, which it is the business of a governing body to guard; and that there would be nothing to prevent the employees of the Council from organising themselves into a separate union for the purpose of dictating the terms of their own employment.

But apart from these details, what effects are to be expected from any such fixing of a minimum?

In cases where the contractors already pay the wages specified, it will produce no effect at all. And there may be practical difficulties in the way of making the regulation effective in any case. First, the difficulty of settling the minimum judiciously—a difficulty which is not unlikely to be increased by parliamentary interference; and, secondly, the difficulty of preventing evasions. It has been suggested, for instance, that a contractor who needs the services of boiler-makers might announce that he intends to engage only general labourers, in which case boiler-makers out of work might be driven to work for him at the lower wage fixed for such labourers; or that he might employ workmen in the character and at the pay of apprentices.

Whether these and other difficulties can be overcome is a question that experience only can answer. But assuming that they can be overcome, and that contractors are in some cases compelled to pay higher wages than they would otherwise pay, who will gain and who will lose by it?

The wages of certain exceptionally low-paid workers will be levelled up to the average in their trade; "sweating" will be restricted. On the other hand, it may be said that the less efficient among them—

the old, and sickly, and ill-trained—will suffer, because contractors who were willing to employ them at a lower wage will decline to employ them at the higher wage.

There is some truth in this; but the objection is less serious than it would be if the regulation applied to private employments as well. Government contractors will have to select workmen whose work does not fall below a certain standard; but the vacancies left by these workmen in private employments are as likely as before to be filled by worse workers at lower wages. Where a better and a worse workman are competing for a place, it is as well that the better workman should have the preference; and the public will be the better served if only the better workmen are employed in its service. If some bad workmen remain unemployed, it may be necessary to give them relief at the public cost—as indeed we have to do at present.

So much for the workers employed by the contractors. But who will pay the cost of the higher wages?

What has been said of a fixed minimum wage in direct Government employment applies to this case also. The contractors, so far as they are compelled to pay higher wages, will raise their tenders by the same amount; and the extra cost will fall on the community. Either the public must do without some Government services, or the individual taxpayers must do without some comforts and luxuries which they could otherwise have paid for out of their private incomes; there will be no diminution of employment on the whole, but there will be some changes in the application of labour-power, and in the distribution of want-satisfaction. If we think the resulting distribution better than the old one, we are free to take the course which leads to it.

If it is ever advisable for Government to take these or other measures to raise certain people's wages, it must be because those wages would otherwise be too low. But at what point is the line to be drawn, beneath which wages are "too low"—so low, that is, that it becomes worth while to take from others in order to increase them? I know no simple answer to this question; the phrase "a living wage" is too vague to give us any guidance. But it would seem most reasonable to make up our minds what rate of pay is to be considered the least on which it is possible to maintain a family decently (whether 6d. an hour, or 1s. an hour, or whatever it may be); to require that this wage at least shall be paid for all work done directly or indirectly for Government; and to leave all rates of pay above this minimum to be settled by free bargaining.

Now that is not quite what the New South Wales Department of Public Works has done; for the effect of its rule is to fix a higher minimum for some kinds of work, and a lower minimum for others. Thus, in the schedule issued, the minimum for masons in Sydney is fixed at 10s. a day, and that for "workmen not included in the foregoing list" at 6s. a day. Now if the purpose of Government interference is to ensure that the workers concerned shall get enough to satisfy their most pressing *needs*, there seems to be no justification for this distinction. If 6s. a day is enough for other labourers, it is enough for masons too; for there is no reason to think that a mason's needs are greater. If, on the other hand, 9s. a day is too little to satisfy the needs of a mason, it is too little for any other labourer also. In fact, the policy of the New South Wales Works Department, as well as that of the London County Council, is to take account of skill *as well as* needs in fixing the minimum. It might be easier to defend a policy which should fix the minimum on the ground of *needs* alone—one minimum for all—and leave *skill* to obtain for itself such better terms as it can get by free bargaining.

But if the minimum is to be fixed on the basis of *needs*, there are some occupations in which interference with free bargaining is more urgently called for than those included in the New South Wales Works Department schedule. The worst-paid workers, both in Australia and in England, are probably those persons—women especially—employed in the lower grades of the clothing trade. It is in that trade that "sweating" is most prevalent—that is, the employment of unskilled and unorganised workers at low rates of pay and under unwholesome conditions.

Of private employment in this trade I will not now speak; but the condition of some of those employed in Government clothing contracts certainly leaves much to be desired. A paper recently read by Miss Gordon before the Australian Economic Association in Sydney, and based on careful investigation, throws some light on this. She says that "contracts for the making of the uniforms of the military, police, railway and tramway men, are let by tender to contractors, who appear to have nothing whatever to do with the making. These contractors sublet the work to another contractor, who again sublets it to several Jew sweaters. These last take a room or a dwelling-house in the neighbourhood of Surrey Hills, hire a couple of low-class journeymen tailors, a cutter, and a presser, and six or eight girls. * * * The great bulk of the work is done in the workers' homes. The prices paid would indicate that the women would have to work hard and long to obtain a sum sufficient to live upon. These tailors and sweaters pay nothing to their apprentices, giving a trifling rate of wages to the improvers, sometimes offering only 2s. 6d. to 5s. a week after working two years; if they ask for more they are turned adrift, and their places taken by beginners at no wages at all; sometimes a specially good worker in some particular branch is kept at 10s. a week."

As to the rates paid for piece-work in this business, I am told on good authority that an unusually quick and highly skilled machine-worker can make 4¾d. an hour, or 3s. 2d. in a day of eight hours, in some Government clothing contracts, and 8¾d. an hour or 5s. 10d. in a day of eight hours, in others; from which something has to be deducted for wear and tear of the machine. The average worker makes less than this, and some, no doubt, very much less. The wages have of late been steadily decreasing, and are likely to decrease further.

It is difficult to get at the facts; but I think I am not wrong in saying that the rate of pay for work under these contracts falls in most cases below the not very generous limit of 6d. an hour, and in many cases far below it.

It is not the contractor or the sub-contractor that is to blame for these low wages. The practice being to accept the lowest tender, those only can obtain the contracts who cut down wages to the lowest point at which they can get the work done. So far as sweating goes on, then, it is Government that is the sweater.

Now, if we consider this state of things satisfactory, there is nothing more to be said or done. But if we think otherwise, can we do anything to alter it for the better? To forbid sub-contracting would not serve the purpose. If the first contractor finds it to his advantage to sublet the work, and if the workers go to the sub-contractor instead of the first contractor for employment, that must be because the sub-contractor contributes in some way towards the result. If those who deal with him consent to do so on terms that leave him a profit, it must be because he renders some service. To exclude him would be to make it more difficult to get that service rendered, and would consequently increase the cost to the public without benefiting the wage-earners. One reason at least for the existence of sub-contracting in this business appears to be that the man who knows how to organise and superintend the work does not usually possess capital enough to give the high guarantee required by Government, and consequently cannot tender directly for the contract.

Mr. Charles Booth, in his evidence before the English Commission on Labour, says on this point—"Sweating and sub-contracting are very far from being synonymous. The middleman's profits are a charge on the work, not on the workman's wages. He is paid for organising labour otherwise very difficult to organise, and his elimination would not, as a rule, improve the condition of the workers."

But we can, if we choose, have inserted in the contracts a condition that wages shall be paid at a rate not less than, say, 6d. an hour, or its equivalent for average workers in piecework, with further regulations as to hours and conditions of work, sanitation of work-rooms, and, perhaps, limitations on employment of apprentices. This course has not hitherto been adopted in New South Wales in the matter of clothing contracts, though it would seem that the need for it is greatest in this business.

A committee of the London County Council, to which the "fair wages" resolution was referred, reported *against* fixing a minimum in clothing contracts, "owing to the absence of unanimity among the trade unions concerned." But it is difficult to see how a want of unanimity among trade unions makes the evil of low wages less serious; and it might rather have been expected that a governing body which aims at mitigating that evil would have begun with those trades in which the evil is manifestly at its worst. Can it be that the reason is to be looked for partly in the fact that the workwomen and foreign immigrants chiefly employed in these trades in London are not, like the stronger trade unions, able to bring voting power and political pressure to bear on the Council—that, in fact, the most helpless classes can be neglected with impunity? Perhaps the committee had other and better reasons for its recommendation; but it does not give them.

However, the question for us is whether there is any good reason why our Australian Governments should not fix a minimum in these contracts. If we desire to do so, and are willing to pay the cost, it is difficult to see why we should not allow ourselves that indulgence, as well as many others which we now order and pay for through our Governments.

It is to be observed that, in this case at least, the higher wage will not mean diminished employment, even in the first instance, for the workers concerned; for we shall certainly not allow our policemen to go unclothed because their clothing costs us a little more. Either the public collectively, or certain taxpayers individually, will have to do without some comforts and conveniences which they have hitherto enjoyed, and will get in return the satisfaction of having their public servants clothed in garments no longer made by over-driven and half-starved workwomen. If we prefer the latter luxury to such others as we must give up to get it, economic science has nothing to say against our choice; and if there is less work for those who have hitherto supplied the indulgences now retrenched, there will be, to the same extent, more work for those who supply the wants of these workwomen.

It would seem then that we can, if we choose to pay the cost, do something through our Government to keep wages up to any reasonable minimum which we may think fit to fix, in the case at least of work done directly or indirectly for the Government. And in Australia this covers a considerable fraction of the whole amount of work done and paid for.

But there still remains the larger amount of work done by wage-earners for private employers. Would it be possible to fix a minimum wage for this work also? And, if so, who is to do it?

The only possible agents would seem to be, first, the trade unions, and, secondly, the Government.

It is one of the chief objects of a trade union to fix and maintain such a minimum at as high a point as may be practicable, *in the case of its own members.* The impartial looker-on, while recognising as so far good any raising of wages thus effected in any trade, will not be satisfied till he has inquired at whose cost the rise has been obtained. So far as it comes out of profits which were high enough to bear some diminution, the good probably outweighs the harm. If, on the other hand, the higher wages cause a great contraction in the trade, the lessened employment may cause more loss than gain even to the very workers whose wages during employment are raised; and if they cause a rise of price for the product, the result will be a loss to all who buy and use the goods. To trace the loss home to all concerned, to estimate the amount borne by each class, and to reckon the good and harm of the total result, is a problem that must be worked out separately in each case, and one so complicated that only those who are thoroughly familiar with the conditions of the particular trade in question can hope to arrive even at an approximate solution.

In one respect the views and aims of the trade unions in this matter appear to have undergone a change. Thirty years ago, I suppose, it was accepted on all sides as a settled principle that the price of the product must be settled by the competition of the market, and that wages must follow prices—a principle which, in some well-organised trades, has been embodied in the "sliding scale." But we now find an opposite principle asserted: "Fix a minimum wage *first;* prices must *follow* wages."

That is the position taken, for instance, by the Newcastle coal-miners in New South Wales. The employers say, "We are making no profit now, and cannot, at the present price of coal, pay higher wages without ruining ourselves."

"That may be very true," the miners reply; "but higher wages you must pay; and if that is impossible at the present selling price of coal, you must raise the price until it becomes possible."

And that is also the position taken up by the English miners in the recent coal strike.

Now, is that policy practicable? And if practicable, is it desirable in the general interest?

To object that it is "contrary to the law of demand and supply" is to talk nonsense. That, if it means anything at all, can only mean that the thing will not be done as long as the people concerned do not choose to do it, but prefer to leave prices and wages to be settled by market bargaining. But suppose they do choose to do it? Suppose that all coal-miners combine in a refusal to work at wages below a certain rate; or that the employers combine in an agreement not to sell coal below a certain price, and to pay higher wages out of the raised price; then, the thing will be done. But would it, on the whole, produce more good or harm if done? That is a doubtful and difficult question. The raised price will cause some contraction of demand, and consequent loss of employment in the trade, especially in that part of it which supplies foreign markets. That will be bad for the miners thrown out of work, and bad for the men in other low-paid trades, with whom they will be driven to compete. How far will that contraction go?

The raised price will also mean a loss to all who buy coal, whether for household use or as a means of production; and that loss will fall in part on low-paid workers. How much distress will that cause? I cannot answer these questions; but they must be answered before we can strike the balance of good and harm to the community.

Even when a trade union is successful in improving the conditions of its own members, that is no gain—it is more likely to be a loss—to the majority of unskilled and unorganised workers; that is, precisely to those who suffer most from the evil of low wages. Every successful attempt of a trade union to fix a higher minimum wage for its own members tends doubly to depress this class; it raises the price of some necessaries which they buy, and, so far as it diminishes employment in its own trade, it thrusts more people down to swell the residuum of unskilled labour, and further reduce by their competition the wages of this lowest class. If a union of coal-miners or shearers succeeds in fixing a satisfactory minimum for its own members, that in no way benefits, and probably to some extent injures, the casual labourers and the workwomen in the clothing trades, whose needs are presumably as large, but whose means are smaller.

It would seem, then, that if anything is to be done for the class below the aristocracy of trade unionism—the class which needs help most and gets least—it must be done by some other agency; and it is difficult to find any other agency for the purpose than that of Government.

For direct Government interference we are hardly yet prepared. It would sound strange if anyone here, and now, were to propose that Government should forbid, for instance, the employment of sewing women, or any other class of workers, at a lower wage than 6d. an hour.

And yet it was not always so. In England, in former centuries, the law ordered the settlement of wages by public authority. *In 1563 Parliament expressly charged itself with securing to all wage-earners a "convenient" livelihood; and by the "Statute of Apprentices" the justices were directed to fix yearly the wages of nearly every kind of labour. These laws were in force, nominally at least, till early in the present century; and as late as 1773 a fresh Act was passed fixing wages in the silk trade.

How far these laws were actually carried out, and how far they served their purpose, is doubtful and disputed; but the fact that they were passed shows that Government in those times deliberately took upon itself the task of fixing wages at the rate considered best.

The last remnants of these wage-fixing laws were swept away by the rising flood of the Industrial Revolution; but not without protests on the part of the wage-earners. According to Mr. Sidney Webb, it became the common purpose of nearly all eighteenth century trade combinations to "appeal to the Government and the House of Commons to save the wage-earners from the new policy of buying labour, like the raw material of manufacture, in the cheapest market." The skilled craftsmen demanded enforcement of the law of apprenticeship; the weavers and others demanded the "convenient proportion of wages" contemplated by Elizabethan legislation. In both cases "the wage-earners turned, for the maintenance of their standard of life, to that protection by the law on which they had been taught to rely."

But the Government was by this time adopting, as a matter of principle, the policy of *laissez faire* associated with the name of Adam Smith. The last occasion on which a wage rate was actually fixed by the justices in accordance with the old law appears to have been in 1805, in the Edinburgh printing trade. In 1808 a committee of the Commons, on an appeal from the hand-loom weavers to fix a minimum wage, reported that "it was wholly inadmissible in principle, incapable of being reduced to practice by any means that can possibly be devised, and, if practicable, would be productive of the most fatal consequences."

The law empowering justices to fix wages was repealed in 1813; and in 1814 were abolished the apprenticeship clauses of the old statute, "and with them practically the last remnant of that legislative protection of the standard of life which had survived from the Middle Ages."

The settlement of wages entirely by free bargaining and the competition of the market, then, so far from being a "law of nature," is merely a modern innovation introduced by our own grandfathers. Shall we ever see similar laws re-enacted at the demand of the wage-earners, and in their interest? That I cannot tell; but it is not impossible.

We certainly could, if we chose to do so, pass a law forbidding any employer to offer, or any wage-earner to take, wages below a certain rate. Whether we could enforce the law when passed is more doubtful. But, supposing that it could be enforced, what would be the effect?

* Webb, "History of Trade Unions.

That would depend largely on the point at which the minimum is fixed. It would be possible (in a Parliament of lunatics) to pass a law fixing a minimum wage of £1,000 a year for coal-miners. But the effect of that would be to close every coal-mine. That wage would, in fact, be not a "living wage" but a starvation wage for miners, and would at the same time mean a coal famine for the country.

Evidently, then, the fixing of a minimum *above certain limits* would be unmixed harm to all concerned.

But what are those limits? And would the fixing of a minimum even a little above the lowest competition rate necessarily and in all cases do more harm than good? That is not so certain.

Any such raising of wages in a particular trade must always have a tendency in the direction indicated by the extreme case; that is, a tendency (1) to raise the price of the product to consumers, and (2) to diminish employment for workers in the trade—the same effects, in fact, which we have already noted as following a rise of wages obtained by a trade union. There is the same difficulty here in estimating the amount of loss that will be borne by each class and group concerned; that depends on circumstances which differ in each case. If, after counting the cost, we should conclude that it is worth while to incur it for the sake of the end in view, there is nothing to prevent us from so doing.

The reasons in favour of this course would presumably be strongest in the case of those employments in which the competition rate is lowest—in the unskilled work of the clothing trades, for instance. If it is on the ground of the needs of the workers that Government is called on to interfere, these are the workers whose unsatisfied needs are greatest; and in lightening the distress of the worst-paid class of all we might have confidence that, whoever may be the loser by our action, it must be someone less badly off than they. In the case of more skilled and comparatively well-paid workers, on the other hand, the need for interference is less, while the danger is greater of inflicting a loss on others who may be poorer. For this reason it might be argued that our imaginary paternal Government, instead of drawing up a schedule of minimum wages for different grades of labour, would do better to fix a single minimum for all employments together—to say simply that no human being shall, within its jurisdiction, be employed at less than, say, 6d. an hour, or 24s. shillings a week, and leave all rates above the minimum to be settled by free bargaining. What would be the effect of that?

The wages of some people who make clothes, for instance, would be doubled or trebled; and consequently some of those who buy clothes would have to give more for them, and to go without some clothes or other conveniences which they can now afford to buy. But the poorest would find compensation for this in the security that their own wages, as long as they are employed, will not fall below a certain figure.

But that is not all. What would become of all the people whose work may be worth 10s. a week and upwards to their employers, but would not, even at the higher selling price that would result, be worth the minimum wage of 24s.? The demand for clothes would somewhat diminish (some people wearing their old clothes a little longer), and the least capable workers would be turned adrift. It would be useless for them to seek employment in other trades; for if a labourer's work is worth little in a trade to which he is accustomed, it would be worth still less in a new one. The effect, then, of a minimum regulation applying to all trades would be to exclude such people from employment altogether.

Any such measure, therefore, must produce an *increase* of distress among the least skilled workers; and if we want to avoid that, Government must again interfere to relieve them at the cost of the richer taxpayers. One way of doing so would be to undertake to provide public employment at the minimum wage for all who want to work, and are not absorbed by private employments—a step which many people are ready to demand. To take that course would indeed in itself be equivalent to fixing a minimum wage; for private employers who offered less than Government pays would find no workers; and this might be a simpler and easier way of producing the effect intended than the direct enactment of a minimum by law.

But the cost would be heavy. The work of many of those who would come to Government for employment, under this method of "selection of the unfittest," would certainly not be worth the minimum wage assured to them; and the deficiency must be met by increased taxation imposed on those whose incomes are larger.

Now, assuming a sufficiently wise, able, and honest Government, I do not know that it would be impossible to carry out this plan—at least in a closed and self-sufficing community; and if it could be done successfully, those of us whose incomes are above the minimum might well think it worth while to pay the cost, to give up part of our incomes for the sake of the great social gain of getting a tolerable living secured to every person willing to work. Whether our actual Governments—the best that we deserve, because the best that we are capable of electing—could attempt it without causing greater distress than ever, is more doubtful. The experiment has been tried before now; it was tried in Paris by the French Government in 1848. That was a bad failure, and caused far-reaching mischief. The Government of New South Wales some years ago tried to give employment in land-clearing and road-making to all applicants. The effect was such as to discredit that policy in Australia from that time to this. Have our Governments so much improved in the last few years as to be capable of doing now on a larger scale what the Government of New South Wales proved itself incapable of doing then? Before we impose on the fairly able and honest public servants whom we call collectively by the name of "Government" so difficult a task as that of organising, drilling, setting to work, and superintending all the most helpless, inefficient, and ill-conditioned workers in the country, we ought to consider whether we are not demanding of *them* more highly-skilled work than they are capable of performing.

But there is still a further difficulty. I said "in a closed and self-sufficing community." But all modern civilised nations are largely dependent on foreign commerce; to cut off exports and imports, whether in Australia or in England, would be to make our labour do so much less towards the satisfaction of our wants that there would be too little to go round, however much the distribution were improved; and while all of us would lose much, the poorest would suffer most.

Now, if in any one country wages were greatly raised *in the trades which supply foreign markets*, the raised price of the produce would restrict, and might wholly destroy, the foreign demand for the produce; for the foreign customer would then prefer to buy elsewhere. We see this in the case of the Newcastle collieries, where the choice seems to lie between low wages for the miners on the one hand, and on the other hand a raised price of coal that drives the foreign buyer away to Japan and elsewhere, leaving a great part of the Newcastle miners unemployed. So far as foreign commerce goes on—and we cannot afford to do without it—the whole world becomes one community, and the wages paid in any one country are partly dependent on those paid elsewhere. The selling price of the product is settled by world-wide competition, and the wages in each country *must* follow the prices. A Government can interfere with competition as much as it thinks fit within its own boundaries; but it is much more difficult to interfere with competition in the world at large.

Is there no way out of this difficulty? Short of a "federation of the world," which may be left to dreamers, the only hope would seem to be that each rise of wages may be accompanied by such a rise of average character and ability, and consequently such an increase of efficiency in the workers, that work will ultimately be done as cheaply at the higher wage as it is now done at the lower wage. It is conceivable that this might be the result in the long run, if higher rates of wages could be maintained for one or two generations. Many facts are given by Schulze-Gaevernitz and others as tending to show that labour is, on the whole, about as cheap in countries where wages are high as in those where wages are low—that the man who draws twice the pay also does twice the work. But then a rise of wages can only produce this effect gradually, if at all; you cannot double the efficiency of this or that particular worker at a stroke by doubling his pay, though there may be some reason for hoping that his children will be more efficient if his income can be by any means increased. And how is the higher rate of pay to be maintained in the meantime?

It seems clear then that, in those trades at least in which prices are dependent on foreign competition, a slow and gradual rise of wages is the utmost that can be brought about, whether by Government or by other agencies.

To conclude, it is probably in our power, if we think fit to do so, to fix a minimum wage above the lowest competition rate in the case of all work done directly or indirectly for Government; and if this minimum is judiciously fixed, it will probably produce more good than harm. The raising of very low wages in private employments also by act of Government is not in theory impossible, and is not necessarily mischievous in principle; but it would have to be carried out with very great precautions to prevent it from increasing the very evils which it is intended to remedy. It is, after all, on the character and ability of all of us together that the welfare of one and all depends, in this matter of wages as in others. The individual worker, if he were an abler workman, a wiser and a better man, could as a rule get better wages for himself, and at the same time help to improve the conditions of his less favoured fellow-workers; the "captains of industry," the employer and the capitalist, if they were better qualified to perform *their* social functions, could so administer the labour under their control as to yield more satisfaction for the wants both of the workers whom they employ and of the public whose demands they supply; and each and all of us, as spenders of money and demanders and consumers of goods and services, could and should, if we were better and wiser men, diminish the enormous waste which now arises from the misdirection of labour power to the satisfaction of wants that would be better left unsatisfied, and leave so much the more to be turned to good purpose for the raising of life to higher levels. Those who conduct our Government, if they were better workmen in *their* line of work, could do more than they can safely attempt now to secure tolerable conditions of life for those who can do little for themselves; and the average voter, if *he* were a wiser and a better man, would elect a Government more capable of doing this.

From the casual labourer to the Cabinet Minister, we are what our past has made us, and our conditions of life are and will be what we, being such as we are, may make them for ourselves and for one another. No machinery of Acts of Parliament or trade regulations can abolish poverty, because no such machinery can make any sudden change in the character and ability of millions of men and women, all mutually dependent. But we are free to hope that the slow and gradual change which never ceases will be a movement upward and not downward. We shall not see the millennium in our time; and hasty and ill-considered attempts to realise it may easily make things worse; but there is always something near at hand that we can do if we will, both individually and collectively, in the way of giving a helping hand to those least able to help themselves. To discover what this "something" may be is the special task of the economist.

Section H.

ENGINEERING AND ARCHITECTURE.

ADDRESS BY THE PRESIDENT,

JAMES FINCHAM, M. Inst. C.E.,

Late Engineer-in-Chief, Tasmania, 1877-94.

It is my duty and pleasure to return my thanks for the honour of election to the office of President of the Engineering and Architectural Section at this meeting of the Association. At the same time, I hope I am fully sensible of my shortcomings for such a position.

We are living in an age of union and co-operation; the various trades have their associations, societies, and unions; the professions their councils and institutes; the churches their synods and congresses; and it is fitting that science, with its catholicity, its far-reaching effects on communities and individuals, should take its place in the forefront, and lead the way to further developments that will eclipse the wonderful advance of the past few decades.

In the old world, and during successive periods of growth, science has created works, which, as the concrete results of the earnest and self-denying labours of her votaries, are the admiration of the world to-day, and the lesson-books for her sons. These labours are being carried on by many master minds in various branches, and will fix and determine principles and conclusions that at present are more or less uncertain.

Engineering and architecture are so related, and are now so increasingly interdependent, that there should be a more earnest and hearty sympathy between the members of the two professions for the advantage of both than often appears to obtain. What observing man can deny this? Who amongst us with any experience but can at once call to mind engineering structures carefully planned for the end in view, well constructed, but simply hideous for all time from the lack of architectural knowledge in or with the designer. On the other hand, how common it is to find architectural work containing structural shams or material piled together for mere effect, in supreme disregard of the composition and resolution of forces. Further, modern requirements now demand the requisite knowledge in an architect, or the co-operation of an engineer, for mechanical details of all kinds; as in elevators, electric lighting, heating, pumping, &c. The very etymology of their names is indicative of union, for the architect of old was the "Chief Builder," a man ready in adaptation and knowledge of material, and of skill in design; while the engineer etymologically is also a "skilful" man, a man selected for skill above his fellows, and so, like the architect, may be considered as the "Chief

Builder." The noblest works of the architects of old are always found in the expression of lofty spiritual ideals, in buildings which they erected for the service and worship of God; and the works of the engineer to-day, properly regarded, may also claim a kindred high ideal of service through the benefits which they confer upon mankind. It is a calling worthy of the highest intellects, and of the same enthusiasm that was displayed by the old "Chief Builders." It is surely high and honourable service to remove dangerous rocks from the course of our ships; to build out massive arms of protection for resisting the attacks on life and property by the ocean in its wild rages; to link people to people by the daring bridge or the patiently burrowed tunnel, and to fight disease and suffering with water and sanitary schemes.

In these new lands of Australasia we are unable to point with pride to such grand and stately works of architecture as abound in England and on the Continent—works enriched with the patient genius and loving toil bestowed upon them by the workmen architects of old. Buildings are, however, to be found that redound to the credit and skill of our architects; but the broad outlook must be confessed as disappointing, when the splendid opportunities afforded by the rise of new and wealthy cities are considered.

I suppose that the advance of architecture in earlier times was largely empirical. Many a failure would occur, and many a lesson be taught from the unskilled use of material, before fixed rules of harmony and proportion were adopted; and the reed, clay, or log dwelling became the grand temple or the stately palace, with the original typical construction yet traceable in a refined and translated form. The advance to-day is more educational, and includes provision for the requirements of a civilisation formerly unknown, as in lighting, heating, ventilating, and lifting arrangements, and in the adaptation of iron and steel to main constructive features.

True architecture is adapted with all simplicity and grace to the purpose of the building, supplemented by the capabilities of the material, social, and climatic requirements, and scenic surroundings. There must be a live purpose felt and expressed in the design, whether made brilliant with genius or simply glowing with an evident desire after honesty and truth in the ideal, and the result will be a "joy for ever." A good architectural design is only so made, never with a mere mechanical grouping and arrangement of set features or, worse still, with a jumble of colour and material that at once is felt to be artificial and a sham.

It is just this live purpose and spirit in the work of the old master builder of the cathedrals of England and the Continent that makes it so admirable, for in the beautiful words of Emerson he—

> Wrought with a sad sincerity,
> Himself from God he could not free;
> He builded better than he knew;
> The conscious stone to beauty grew.
>
> Know'st how yon wood-bird builds his nest
> Of leaves, and feathers from his breast?
> Such, and so grew those lofty piles,
> While love and terror laid the tiles.
>
> The pliant master lent his hand
> To the vast soul which on him planned:
> And the same power that raised the shrine
> Bestrode the tribes that knelt therein.

The careful study of the proper use and treatment of the different materials to be employed is quite as necessary to a successful design as that of correct lines, harmonious grouping of parts, and the proportions of the whole. A building entirely of stone, enriched and relieved by the workmanship, or, at the most, with slight varieties in colour in addition, or a well-built brick building with pressed and moulded bricks, and, if further relief is needed, with some harmonising variety in colour of the bricks, or with terra-cotta work, is always, I think, more effective and grateful to the eye than any arrangement and mixture of material essentially different in chararacter and composition.

With regard to city architecture as a whole, I hope the day will yet come when a cultivated public taste shall so rouse people to the grace and elegance that it might exhibit in more harmonious groupings, and so open their eyes to the ugliness to which they have become blind by familiarity, that the authorities will not only employ officers to control structural, sanitary, and other matters for the good of all, but in addition, other officers, fit by training and education to exercise control over the architecture of the buildings erected in the principal portions of the cities, so that not only glaring offences may be prevented, but a harmonious grouping be obtained. You may perhaps smile at these hopes as you remember the respect demanded for the "liberty of the subject"; but why should it not be kept within bounds, if blots, ugliness, and vulgarity result, just as a proper check is now exercised over the noxious trades, discordant noises, and other nuisances that offend against the peace and welfare of the public?

There appears to be much room for study in the better architectural treatment of buildings constructed of iron and steel, and necessitated by the demands of modern business and traffic in warehouses, manufactories, and railway stations, in order to get the best effects from these materials, which from their nature admit of designs of airy grace and lightness if boldly treated on their merits; while their use as skeleton framing on which to hang a wholesale veneering of marble, stone, wood, or concrete, for column, cornice, pediment, &c., cannot be commended as good architectural practice.

The proper place for concrete building is in the foundation, where its monolithic character is invaluable for distribution of the superincumbent weight of the structure supported, or—used in connection with some of the many systems of strengthening it by a centre "webbing" of iron or steel rods—for vaulting and arches.

In engineering, the swift succession of new developments and applications of science makes any general review too large a task, but, as standing out in more prominent relief, we may note the attention given to large ship canal schemes, involving an expenditure of scores of millions sterling; the revived interest in inland navigation, and its working with electric motors; the multifarious schemes for overcoming the problem of best method for rapid transit in large cities; the distribution and sale of power; while looming in the not too distant future is some form of successful aerial navigation; and the construction of the great bridge over the Hudson River at New York, with its span of over 3,100 feet, and its accommodation for six lines of railway, the designs having been certified by a board of the ablest engineers in America.

Our engineering and architectural public works in Australasia must be considered in the aggregate if we would realise their magnitude, and we can gauge this by the expenditure upon them, which amounts to some £200,000,000 sterling, of which about £120,000,000 have been spent on railways. This latter sum has not been inflated by large preliminary expenses in battles with rival lines, as in England and elsewhere, but, as regards the extent and quality of the works, is on the whole no doubt really good value for the outlay; yet I make bold to assert that a large portion of this expenditure has been premature, when the needs of the colonists over large areas, now for a long time served by lines of a branch or pioneer character, are considered, and as indicated by the fact that a service of one or two trains per diem has been, and is likely to be for some time yet, quite sufficient for such needs. These lines, with others outside the main trunk routes, have been built and prepared for a traffic yet to come; and, when it does come in the future, who shall say that the whole system of haulage for which they have been designed will not have been largely revolutionised, and hundreds of thousands, or rather millions, of pounds be found practically thrown away on works quite unnecessarily high in first cost, and entailing a burden in maintenance and interest that is cruelly felt directly any period of financial depression occurs. One great evil of this over-building for a very limited traffic is that it places a premium upon demands for working at much higher speed than the traffic warrants, and entails a corresponding loss in working; for high speed, as every engineer knows, means rapidly increasing cost in every department of working, and the haulage of heavier rolling-stock; and what this means let me point out by a few figures:—Generally, and if the goods wagons were always worked to their full load capacity, the proportion of dead load to paying load may be taken as 1 to 1·75 or 2; but, allowing for "empties" and the varying conditions of roadside traffic, I do not think we should be far out to take the reverse of this proportion as the prevailing general and actual average, or a dead load of 1·75 to 2 tons to a paying load of 1 ton; in other words, on the railways of Australasia is hauled an aggregate dead weight of from 21,000,000 to 24,000,000 tons of rolling-stock for transport of 12,000,000 tons of goods per annum! Granted that much of this is at present unavoidable from the exigencies of traffic, and a large margin is still left for the exercise of economy, in the construction and working on many lines, where necessity demands provision for traffic that must be comparatively limited for a long time to come.

While the financial conditions of these colonies will make the study of the utmost economy in the working of existing lines to be incumbent on their engineers, the extended construction of new lines cannot be long delayed, with vast areas awaiting population coming from natural increase, from immigration, and from the exodus of city populations driven back on to the country lands; but the difficulty of providing the interest on capital outlay, for sufficient mileage of the normal type of line to open out the country, would be too great, and therefore the consideration of the construction of good serviceable pioneer and feeder lines at a lower limit of cost is one of considerable importance.

Because mistakes have been made in the past by constructing as "light lines" railways that soon became quasi main lines, unequal to the strain of traffic put upon them, or because, from some public or political influence, a "light" line that would have served all needed requirements, is ruined by working it under speeds and conditions for which it was never designed, in order to serve a comparatively insignificant and unproductive passenger traffic; therefore it has been the fashion to condemn these light pioneer lines, without too much or any thought on the matter.

The only traffic of consequence to be anticipated from a pioneer line run into virgin country, or for a feeder line to tap agricultural settlements hitherto out of reach of communication, is a goods traffic, the actual or prospective passenger traffic being likely to form but a small proportion of any returns to revenue. But hitherto in this class of lines the undue consideration given to the few passengers has been the cause of a vast amount of unnecessary outlay in first cost or subsequent alteration.

I would therefore advocate the construction of the class of lines I am dealing with as essentially "goods" lines, working them at slow speed, and designing them to afford the fullest facilities for collecting and encouraging the utmost amount of traffic, untrammelled by the expense and restrictions inseparable from the working of ordinary lines where passengers are concerned, and are numerous enough to justify the same, thus creating real "feeders" and not "suckers," owing to costly capital outlay and working expended on them. The whole of the works should be as inexpensive as possible, not by the use of inferior materials or labour, but by limiting the extent to the requirements of a traffic not exceeding a speed of from eight to ten miles per hour as a maximum, and by the introduction of sharper grades and curves to reduce first cost, for these would not so much affect prejudicially the working of small volumes of traffic, and on a well-designed line need leave but a small amount of reconstruction at some distant day when the traffic has grown sufficiently to justify it.

One important question—that of gauge—at once suggests itself in any consideration of cheaper railways, and I would say without hesitation that, given fairly easy ordinary country, the gauge should not differ from that of the system to be joined; but in dealing with the problem of cheap transit over a broken and mountainous country, to reach the main system, it may, I think, be perfectly admissible to adopt a reduced width of gauge, in order to reduce capital cost and encourage or develop a traffic—the ready *non-possumus* of some of my railway friends notwithstanding. Any inconvenience, connected with transfer of traffic at the junction, can be easily and cheaply overcome with suitable mechanical appliances, and in a satisfactory manner, while the cost of transfer need not exceed 1d. to 1½d. per ton as a junction charge.

One requisite for a cheap line is an exhaustive survey—to give the very best location for the design in view, a greatly limited first cost, future facility for improvement to the standard of other lines, extended facilities for short turn-outs and sidings to works, manufactories, or farms.

In fairly level country and where the Crown lands have been alienated advantage might be taken of the reserved roads to some extent to save outlay in purchase or compensation; but generally a surface line on easy grades should be as far as possible selected, even if length is increased, and, in surmounting fixed points of elevation, a short sharp grade at the summit with a long easy approach would be preferable to an average of the two grades.

The lines would need partial fencing, but this is not an expensive item, while surface cattle-guards would form a sufficient and cheaper substitute for gates at road crossings, and at divisions between open and fenced lands, than the pit cattle-guard. With good drainage both earthwork and ballast could be saved, and where the formation is generally hard the latter need not average more than a nominal quantity. The determination of weight of rail, whether lighter or heavier, would be dependent on the varying conditions of cost of manufacture and transport, but at present low prices any trimming in the weight of rail is poor economy. Very much of the usual expensive paraphernalia of the stations could be dispensed with, and a short loop with a goods platform and store for small goods serve all purposes. Turn-outs should be provided as frequently as possible to junction with branch sidings to private properties or manufactories, &c., with actual access to the main line kept in control of trainmen by locked gates, stop blocks, &c., and generally every facility be afforded for collecting and distributing traffic *en route*.

The transfer traffic at junctions when, as before indicated, circumstances necessitate a break of gauge, can be easily facilitated, and cost economised, by a travelling or overhead crane with a couple of short sidings and platform; making the wagon stock with false bodies in one or more parts that shall fit into and fill up without waste of space the larger-sized stock of the general system, and these part-bodies would prove convenient in many ways in concentrating the loads for distribution in traffic.

The loading and unloading throughout a journey could be rapidly effected by the trainmen with the assistance of a light travelling crane on the locomotive or train.

Of course, under such a system of working, there would be no need for any rigidly fixed time-table for the intermediate traffic, and the lines would be worked independently, so as to avoid the otherwise contingent restrictions and consequent expenses. While keeping the lines to the primary purpose of goods transport, there would be no difficulty in making occasional provision for a special passenger traffic, as on holidays, with sufficient precaution at the same speeds.

Such railways as these could be constructed and equipped for less than one-half the usual outlay in varying places and character of country, while the working expenses would be very considerably reduced from the greater freedom of operations that becomes possible. Let us hope that one outcome of the past financial trouble and depression will be a new departure in favour of a class of pioneer and feeder lines more suited to our real requirements and finances than so many of those which have been built, and that the path along which I have ventured a few steps may, with the help of abler engineer members of this Australasian Association for the Advancement of Science, be wrought upon and widened out into a broad well-travelled highway for the benefit and prosperity of Australasia.

I had intended when commencing this address to have offered some account of the public works of Tasmania with which I have been so intimately connected for more than twenty years, and also to have made some reference to the successful operations of the Hobart electric tramways—the first of their kind constructed in Australasia; but it would make the address too long, and I must therefore await the favour of some future opportunity.

Section I.

SANITARY SCIENCE AND HYGIENE.

ADDRESS BY THE PRESIDENT,

J. W. SPRINGTHORPE, M.A., M.D., MELB., M.R.C.P. LOND.,

Lecturer on Hygiene, &c., University of Melbourne; Physician to the Melbourne Hospital.

THE TEACHING OF SCIENCE IN MATTERS OF HEALTH.

Upon matters of health, as upon all matters of human interest, three voices have, during the ages, claimed to speak to man with more or less of authority—the voice of the priest, the voice of the philosopher, and the voice of the scientist. Each in turn has dominated the rest, none have ever become perfectly silent, and all have possessed, and probably still possess, a distinct value.

It is not without interest to find that their pre-eminence corresponds in the main with developmental periods. Thus, explain it how you will, the voice that mainly arrested attention in the childhood of the race was that of superhuman authority, vested in the seer. Then it was the priest that was the medicine man; health was the gift of the gods, disease the result of their displeasure. In time this voice became clothed with the added authority of the established religion, so that even in early European history we find different organs of the body placed under the care of patron saints, and different remedies introduced by special form of supplication. Nor is this authority without honour in the present day. Within the last few months we read of cholera being exorcised by the sign of the cross at Kazan in Russia, of the plague treated by incantation in China, and "faith cures" reported in both France and England. And by many who regard such miraculous results rather as the effects of expectant attention upon plastic minds, the registered, or (as perhaps even oftener occurs) the unregistered practitioner of their choice, is still practically regarded as one who by pills and potions can secure health and banish disease.

With advance in civilisation, however, we find very generally that the authoritative utterance of the priestly medicine man becomes challenged, and it may be even dethroned by another claimant—the voice of cultivated human reason. Now it is the philosopher that is the healer, and disease is a matter of finely woven theories, spun with the thread of introspective subtleties. In the medicine of the middle ages we see what these authorities could do in conflict and in concert. I am aware, of course, that from the time of Hippocrates the tradition continuously existed that the healer should be a student of nature; but it will be generally admitted that the designation "physician" was used in name only, and that for all intents and purposes the dominant note was that of priest and philosopher. In the object lesson thus afforded, what is the lesson for us to learn? Surely that, though individual improvement might have been far from uncommon, the necessary climax was superstition and introspection, and that as guides for the maintenance of health and prevention of disease, these two authorities, seer and philosopher, have both been tried, and both been found wanting.

A striking characteristic, however, of more modern times has been the rise and crowning of the third adviser, Science—the science that works through accurate observation, exact experiment, and logical deduction therefrom. And upon an occasion like the present, when we are met to advance the bounds of knowledge, it can scarcely be an inappropriate introduction to the section devoted to matters of health to inquire, even though imperfectly, into the ways and means by which this new mentor purposes to deal with this all-important subject. In doing so I am, of course, representative simply of my own opinions, but still they are opinions which have been scientifically acquired, and which are also in accord with those held by many scientists of repute.

In dealing with such a complex subject it is difficult to know how much to present and how much to omit. Perhaps my attempt will be least inefficient if I sketch the important outlines, and leave the details to be filled in by individual additions. At the outset we must remember that this new guide has very definite limitations. Enveloped, as we are to-day, by its manifold achievements, and, apparently, as we hope, only at the beginning of its triumphs, we cannot forget its inherent imperfections. Its servants, the senses, are unfortunately very far from being universal informants, and with all the inventive assistance that our ingenuity can give them, they can never make us thoroughly acquainted even with the material universe.

Nay, come up higher: from this wave-washed mound
   Unto the farthest flood-brim look with me;
Then reach on with thy thought till it be drowned,
   Miles and miles distant though the last line be;
And, though thy soul sail leagues and leagues beyond
   Still leagues beyond those leagues there is more sea.

And beyond the material, stretch out the deeper problems of life, mind, and moral sense, each of which baffles investigation and refuses solution. We must expect, therefore, to find change and incompleteness marking the teaching of science in this as in all other departments of knowledge, though the variations should affect details and applications rather than principles. *Per contra*, our new guide will be reliable so far as it presents the facts, and with ever-increasing completeness will come ever-increasing efficiency.

But to interfere wisely we must have some definite conception and knowledge of the constitution of the being whose health is concerned. Is there, then, a scientific definition of man? To the priest he is "the offspring of the gods," to the philosopher "the child of reason," and to the scientist possibly both of these, but certainly "the heir to the ages." And unknown as may remain his origin, to science development seems the road along which he has travelled, and he is linked to the past by many unbreakable ties. Inexplicable, also, as is the inter-connection, science finds in him a physical framework endowed with life, a conscious mentality, and a moral sense invested with some freedom of will. In all this it may differ only in degree from the oracular and the scholastic, but in its method of dealing with this complexity it stands alone.

Take first the physical framework. This man is found to share with the material universe. By it he is brought under the iron heel of material law; transgression has for him the same consequence as for other non-human combinations of matter. A first necessity of his well-being thus becomes obedience to physical law. The vital endowment may, of course, introduce new complications with which, however, science cannot deal, but the resultant life, as we know it, is in some inscrutable way bound up with matter, and its well-being is markedly influenced by material agencies. To every vital act, indeed, there is a material setting; and it is with these material concomitants that science is fundamentally concerned. One thing at least, however, the vital endowment is responsible for—it brings us into relationships of the highest importance with the universe of life around, and binds us man to man, man to plant and animal, and man to germ.

Similarly in the eyes of science the mental and moral are matters of development, and do not at once appear fully formed, as Athena is fabled to have sprung from the brain of Zeus. And whatever their origin, they too are so interwoven and bound up with material conditions, that for practical purposes their manifestations may be expressed in terms of material equations. The physical, indeed, reacts upon the mental and moral, just as they in turn react downward on the physical, and there is a material concomitant and even basis for thought and conduct, material causes for mental and moral disease, and material factors in mental and moral health. Nor does science seem to me to deny the possession by the individual of some inherent determining power whereby he can originate as well as respond. But, as a factor in life, this freedom of the will (however tremendous the results which theology rightly or wrongly traces to its abuse) ranks rather with the epicycles of the old Ptolemaic astronomy —little wheels attached to and moved with much larger wheels, and capable of independent movement only within certain narrow limits. Intentional disregard of the laws of health, apart altogether from material causes, remains thus a causative agent, but increasing observation seems to be ever lessening the area of its operations.

Such, I venture to think, fairly represents the present scientific conception of man. The definition prepares us for the mode of intervention. Health must be in the first place very largely a matter of inheritance. It is worse than useless—it becomes contrary to natural law—to expect healthy offspring and yet disregard heredity. So far, of course, as mind and soul are concerned, apart from the physical basis, it is impossible, scientifically, to say whether there is or can be any such thing as inherited defect or excess. Far different, however, is it with the living physical basis. We can, within limits, compute the size of a molecule; we can calculate the number of such molecules in a living cell, and thus, as Weismann has shown, frame a mechanical plan of heredity capable of explaining most, if not all the phenomena of inheritance. It is no longer a question of "egg from egg," or even "cell from cell," but "molecule from molecule."

Thus man, like other organisms, is started upon the way of life with all his possibilities conditioned by inherited molecular potentialities, and science would shut its eyes to omnipotent law if it did not recognise the fundamental influence of appropriate marriage upon the health of the offspring. Yet, how frequently, from want of recognition of this sanitary axiom, is the start in life made with the momentum towards disease rather than towards health. Let three illustrations suffice to show how far-reaching the results. Take, for example, those whose cells can scarcely stand up against the wear and tear of existence, much less withstand stress and strain. Such inherited vulnerability is responsible more than anything else for premature decay, and for the onset of a host of diseases, prominent amongst which comes that which kills at least one-sixth of the civilised world—tubercular disease. Or take, again, the large class of the rheumaticky, the gouty, the dyspeptic, and the nervous. In a large proportion the sufferers have to thank their ancestors for their disease tendencies, and the fact that in many, such as the nervous, the law continues to ignore this inherited factor, is extra reason why science should continue to draw clamorous attention to the falsity of the legal position. In subtler guise, too, this inherited defect lies at the root of those numerous peculiarities, physical, mental, and moral, which characterise individuals of ill-balanced temperament. Hence it is that the neurotic almost of necessity live a life of unreasoning impulses, unnecessary anxieties, and bodily discomforts, whilst the hepatic are ever subject to numerous congestions and system-wide irritability; and it is only with the spread of scientific knowledge that a juster judgment of such cases becomes possible, and prevention is attempted where cure is impossible. But enough has been said to indicate how an incalculable amount of disease would be averted, and a corresponding amount of health secured, if only inheritance could be scientifically regulated. How far we are from such attempt must be patent to all. Here, at the end of the nineteenth century, we still take less pains to breed men than to breed any other domestic animal. What we require is not the poor thing called State legislation, but the wider diffusion of knowledge, and the direction of "marriage by natural selection" into more satisfactory channels, by closer attention to those underlying factors—opportunity and propinquity.

Inheritance, however, does not explain all life, much less all health; both are also questions of development and environment. It is, of course, a commonplace to remind anyone how largely health depends, for example, upon such everyday matters as food and drink, exercise, recreation, and rest, and attention to the different functions; and yet it is the commonplaces that are all-powerful. And how wide-spread do we find ignorance and neglect upon these very points, and how disastrous the results that follow therefrom! Take, for example, the great question of food. According to Sir William Roberts, one generation of scientific dietetics would produce an influence upon humanity second only to a new creation of the race; and yet through improper feeding there are more deaths amongst infants than occur during all the years that follow. Again, science places a certain limit to the amount of meat suited to the requirements of the adult; and yet Australians continue to eat three or four times this quantity, with the result that they are developing distinct tendencies to certain diseases, and suffer very largely from preventable ill-health. Or take the function of the bowels:—Inattention produces costiveness; this is relieved by purgatives; fresh purgatives are taken to overcome the consequent atony; their continuous use soon becomes a necessity, and the vicious circle is complete; and, as a mark of the extent of this misuse, Holloway, Cockle, and Beecham are names more widely known than Gladstone, Bismarck, and General Gordon. Mistakes such as these with the commonplaces of health show us conclusively that their functional requirements need scientific regulation, and being matters of individual application should be made subjects of primary education. Surely they are of more importance than the dates of battles that have no present interest, or the heights of mountains that are never seen! I am glad to be able to say that such matters are now part of the State education of Victoria, and I venture to think that such and similar health-teaching deserves a place in the education of every community.

Nor must we forget that, like other living things, this body of ours has its life history. There are in that history epochs of growth, maturity, and decay. Each epoch presents its own special perils and morbid imminences, and it cannot be too often emphasised that decay is as natural as development, and that many forms of "disease" are in reality nothing more or less than natural modes of decay. Upon this point there is such an excellent article by Dr. Southey in Quain's "Dictionary of Medicine" that I venture to draw special attention thereto, and, by way of incentive, quote his final remarks. He says: "Advice for every age may be thus briefly given—for infancy and childhood, *sustine;* for adult years, *sustine et abstine;* for old age, again *sustine.* Individual health is attained by self-denial; habits imply self-indulgence."

The great question of exercise has such an important influence on health that it cannot be passed by entirely without notice. Of the value of the systematic training of the body there is little need to say much in a community where the danger is rather that of athleticism run mad than the reverse. To the old Grecian conception of exercise, as a necessary factor in harmonious development, we add the more practical Roman view that it is necessary for health—the only points to be considered are the amount and the kind. Sir James Paget but voices the general scientific opinion when he upholds the English system of competitive games as pre-eminently useful in the case of the young and the maturing. But some supervision is often necessary to prevent its misuse, and some combination with scientific gymnastics may also be required to counteract its defects. Such a system as that known in America as the "Sargent system" thus receives a scientific warrant. Especially is this of value where it is too often especially neglected—namely, in the case of girls and young women They, even more than the opposite sex, need the protection and assistance of a well-developed bodily frame, and the doctrine of systematic exercise for girlhood cannot be too widely or too loudly proclaimed. And turning to mature life, exercise has peculiar advantages which are far too seldom recognised. Healthier and happier will be ever be who then, as Lynch puts it, exercises daily *ad ruborem* if lean, and *ad sudorem* if fat, than he who, unmindful of the benefit that accrues to heart, lung, and brain, abandons the exercise of his youth.

Equally with the physical, the mental side of the organism needs to be developed and exercised if the best health is to be enjoyed. The question of mental education is at the outset simply the problem how to bring the more important of the vast universe of facts within the reach of the senses. And it is because this—the true aim of preparatory education—is best attained in the method of the Kindergarten, that I venture to hold it up as somewhat of a model of what the healthy mental training of childhood should be. It is later on in life that the reflective faculties come into play, and need in turn their progressive and systematic exercise. This cultivation of the reason and the judgment should follow, not precede, the training of the powers of observation.

In both processes the scientific requirements are that the exercise be suited to the age, not excessive in amount, satisfactory to the tendencies, and continuous throughout life. Upon many of these grounds the modern competitive system, with its inevitable "cramming," stands self-condemned. In how many cases, indeed, may we not almost agree with the authority who wrote, "Could we but see all the changes incident upon it, we would see how mad they are, and how much the dull are to be envied rather than the successful, the flattered, and the triumphant." And to gain this verdict "overwork hurries its thousands of unrecognised victims into an early grave." Nor is this all. Too frequently the combination is that of a mind overworked in a body unexercised. But to expect to know truly and reason correctly without a healthy exercise of the servants of the intellect, is as foolish as for the chemist to rely upon discoveries made in unknown test-tubes, and with indefinite reagents. Hence it is that many to whom the world looks for guidance lead it astray, and many who should enjoy mental health suffer from intellectual discomfort and dissatisfaction. Nor can I omit to remind you how science insists upon a healthy school-room and due regard to the needs of the different senses. It sees that the eye is not improperly strained; that the "stupidity" is not due to defective hearing produced by post-nasal growths; that ventilation, light, and cleanliness are present, and infectious disease absent. It remembers that hunger must be appeased before the brain is exercised, and that school is the place in which to teach, not to hear what has been laboriously learnt at home.

The wise direction of the moral sense is also a sanitary matter that cannot be disregarded. The influence of the moral sense is not all ethical and ideational, but descends into every-day life, and brooks no interference even from the intellect. But it has been peculiarly the province of science to show how largely its phenomena are bound up with the state of the physical basis. Thus, into an organism is introduced a physical reagent—cocaine. The result is not only physical ill-health and mental hallucinations, but also lamentable moral perversion. Or too much nitrogenous waste circulates in the blood, and amongst the effects are not only physical convulsions and mental explosions but alterations in conduct and in morals. What mother, indeed, has not noticed that peevishness and perverse behaviour arise when there is unexpected delay in the child's breakfast? The passing show of sleep and dreaming, the sad marvels of insanity, the vagaries of the hypnotised all illustrate how essential the dependence of the "ego," even in its moral aspects, upon the healthy condition of the physical basis. The trouble is that we find the moral sense unprovided with any set of trainable scouts. Fortunately, however, the law of association is as potent here as in the physical and intellectual. And, in view of the unsatisfactory condition of this factor in healthy life, there seems special need for emphasising the scientific view that for its well-being we must pay increasing attention to the physical concomitants, and bring the influence of association to bear as much as possible upon the development of what appear to be the basement ideas—self-mastery, reverence, and regard for the rights of others. But who finds place for these in a modern curriculum?

But man exists not only as an individual but also as a member of a community, and it is in this category that we can deal with him from the standpoint of environment.

The public health, in which man shares, is essentially the province of the hygienist, and as such has received an amount of observation, research, and registration, that can scarcely be equalled in any other branch of science. It has formed health departments in the State, shaped legislative enactments, created vast congresses, and become part of the literature of the day. Its ramifications and attempts would surprise anyone not specially cognisant of the subject. Thus think of the sections into which the Hygiene Congress of 1891, for example, was divided: Preventive medicine, bacteriology, relation of diseases of animals to those of man; infancy, childhood, and school life; architectural, engineering, naval and military hygiene, State hygiene, demography, health statistics, and industrial hygiene; As a contribution from science to health, this surely establishes a *monumentum ære perennius*. Would you have summarised some of the results already achieved? Then ponder over the following table, quoted by Sir Joseph Fayrer, the President of that Congress:—

Years.	Death Rate per Thousand.
1846—1855	24·9
1866—1870	22·4
1870—1875	20·9
1875—1880	20·0
1880—1885	19·3
1885—1888	18·7
1889	17·85

In some parts of England, he adds, where the main object is the recovery or the maintenance of health, the death rate is down to 9 per 1,000. And, as instancing the way in which science has come to regard disease, I know nothing better than the standards mentioned by Surgeon Billings at the Berlin Medical Congress of 1890. He there takes the statistics of smallpox as the test of the administrative efficiency of vaccination; those of typhoid fever, cholera, and dysentery as indicative of the character of the water supply; pulmonary phthisis, pneumonia, acute bronchitis, and tonsilitis as measuring defective and impure air supply; and scurvy, alcoholism, diabetes, and rheumatism as illustrating defective assimilation from improper diet, imprudent indulgence, or exposure.

Perhaps in no department of public health has the influence of science been so marked and valuable as in that of infectious diseases. To science we owe the discovery of the true causes of pathogenic micro-organisms, their isolation, cultivation, and life history, and the determination of their exits and extrances. To science we owe the proof that infectious disease represents simply the fight between the organism and the germ, that infection and spread depend mainly upon constitutional vulnerability, that some ages and persons possess more or less immunity, that abrasions of mucous membranes and variations in the local germ flora may be necessary to permit of successful attack, and that bound up in the products of germ life are the anti-toxines which destroy their virulence. And to science also we are indebted for the preparation of some at least of these anti-toxines and the attainment of some measure at least of artificial immunity. By antiseptics and aseptics, also, science helps us to prevent germ invasion, by disinfection to limit germ exit, by general sanitary measures to destroy external breeding-grounds, and by adding force to the organism to confer immunity. Herein, then, lies one of the greatest possibilities of the art of preventative medicine, and one of the most sustained and promising efforts of science at the present day. But for the perfect success which is to usher in the sanitary millennium when there shall be no more infectious disease, see what is necessary! We must have dealt satisfactorily with all the disease germs already outside our body, and we must be able to render entrance and exit of fresh germs an impossibility, or, what will come to the same thing, confer racial immunity. There is no present possibility of any of these herculean tasks being performed.

But you will naturally be asking, Is there to be no writing of prescriptions, no place for drugs in the future treatment of disease? Unfortunately, yes. There will still be disease due to inheritance, to ignorance, and to disobedience, and the scientific physician will still have to call into his aid all the means in his power in order to make the pendulum swing once more in the direction of health. And though his main influence will be educational and preventative, he will still avail himself of drugs, not with the idea of replacing obedience to natural health laws, but with the hope and aim of assisting nature. But Therapeusis, of necessity, must ever remain the most backward and difficult of the medical sciences. Yet there are many indications that its advance is in no way unworthy of the progress of its sister branches. Possibly vegetable and mineral have already yielded most that is best in them, but in serum therapeutics and organ therapeutics we see that we have still much to learn from the secrets of animal life; whilst man's synthetical skill has already produced in the laboratory remedies which have been found at the bedside to have something more than the promise of specific action upon specific organs and functions. And when the great branch of treatment by suggestion shall have been rescued from the quack and charlatan, and placed upon a scientific footing, the physician of the future will have no reason to confess inferiority in methods or results to other experts in other branches of knowledge.

Let me touch briefly on certain health questions of general importance, and I have done. No outlook upon health would be other than seriously incomplete if it did not include some reference to the drink problem, the sexual question, crime, and insanity.

The drink problem is ever with us. Is there any word from science upon it? In my opinion the answer is that, like opium and hashish, alcohol is a stimulo-sedative, almost demanded where the individual is living an artificial life and with dissatisfaction, recognised or not, between his actualities and his possibilities. No doubt it is the immediate antecedent to much poverty, ill-health, and vice; but it is also a measure of the extent of systemic dissatisfaction, and a ready means of procuring a fool's paradise, where none other is attainable. For a man healthy, well-housed, well-fed, living a healthy life, it is unnecessary, but in a large proportion of people these conditions are not present. And especially during maturity, mid-life, and when age is advancing, if used in moderation and in form suited to the individual, it is generally of distinct value both as an adjuvant to digestion and a general stimulo-sedative. But where it is used in place of attempts to bring the individual into better accord with himself and surroundings, the end is bound to be "physiological bankruptcy." Something more radical and more sanitary than teetotal pledges, local option, and legislative prohibition will thus be required before the evils attendant on drink can be abolished.

Again, an instinct like the sexual, which is the second strongest in our nature, which pervades much of our literature and more of our thought, and which as a social factor is inferior to none, cannot be ignored in a paper on health.

The fact is that silence has too long been kept on this matter by competent guides, and disaster has been made complete by the policy of handing the matter over to inexperience or quackery of the grossest kind. To me it seems that there is only one sound way of meeting this dominant appetite under our social conditions, and that is marriage when practicable. But civilisation has had the twofold effect of increasing this, as all other sensibility, and of delaying very seriously its appropriate gratification. Until, therefore, statesmanship produces conditions which will bring marriage within a reasonable distance of early maturity, nothing is possible but temporary expedients; and the only commendable expedient is self-restraint. This may be materially assisted by the removal of physical conditions which necessitate trouble, and by explanations which will carry knowledge, even though, of themselves, they cannot promise self-restraint.

In crime, again, science sees much more than the results of "the party's criminal will." It recognises inheritance as a factor, and an almost uncontrollable tendency to wrong-doing as frequently an inherited disease. It proclaims, therefore, the folly and wrong of continuing to breed criminals. Further, it finds in environment an even more exciting cause, and demands therefore, as a second essential in the scientific treatment of crime, a removal from contaminating surroundings. And how much ill-health would be averted if these considerations guided our penal laws?

Similarly, to science insanity is a disease, and one which is increasing with the stress of civilisation. It is no wonder, therefore, that people said to be insane come before our courts in increasing numbers; but the legal definition by which alone they are judged is, as the late Chief Justice of England said, "contradicted by modern science," and has been shown to be wrong in theory, false in fact, cruel in its metaphysical conception, and unreliable in its practical application. Still reform, though thus eminently desirable, might be impossible were there no consensus of scientific opinion as to the direction in which it should proceed. But what is to be said when the medical profession has taken up this challenge of the law authorities, and come to an authoritative agreement upon the point? Surely that continued adherence to a fallacious test, with the injustice and cruelty that must attend it, is the fault of legal not of medical science.

Here I must conclude my imperfect sketch. Of its imperfections I am only too conscious; still I am hopeful that even it may stimulate thought and further inquiry, and thus lead to some practical good. For the result of following the guidance of science in matters of health must be increasingly beneficial. No doubt the factors of ill-health are so much with us that none of us can hope to see established upon earth the city of Hygeia, peopled with citizens in perfect health; yet the sanitary millennium lies before us, not behind, and all succeeding years will witness a continuous, if gradual, decrease in the amount and degree of disease. But even after the long years of physiological plenty have followed the centuries of inherited defect, ignorance, and disobedience—even when there is growth that is perfect and life that is without a flaw—there will still remain a decay that is harmonious, and the dissolution that ends life's partnership. And the members of the new firm? Who can tell? Certainly not the scientist, though he can formulate a rational basis for belief, and within such belief include a future that has no bounds to its possibilities.

Mysterious Night! when our first parent knew
Thee from report divine, and heard thy name,
Did he not tremble for this lovely frame—
This glorious canopy of light and blue?
Yet! 'neath a curtain of translucent dew,
Bathed in the rays of the great setting flame,
Hesperus, with the host of Heaven, came,
And lo! Creation widened in man's view.

Who could have thought such darkness lay concealed
Within thy beams, O Sun? or who could find,
Whilst flower, and leaf, and insect stood revealed,
That to such countless orbs thou mad'st us blind?
Why do we then shun Death with anxious strife?
If Light can thus deceive, wherefore not Life?

Section J.

MENTAL SCIENCE AND EDUCATION.

ADDRESS BY THE PRESIDENT,

FRANCIS ANDERSON, M.A.,

Professor of Logic and Mental Philosophy, University of Sydney, N.S.W.

POLITICS AND EDUCATION.

[*The manuscript of this Address was not forwarded in time to be inserted here. If received before the volume is completed, it will be found in an Appendix.*]

PROCEEDINGS OF SECTIONS.

Section A.

ASTRONOMY, MATHEMATICS, AND PHYSICS.

1.—ON THE MOST PROBABLE VALUE AND ERROR OF AUSTRALIAN LONGITUDES, INCLUDING THAT OF THE BOUNDARY LINES OF SOUTH AUSTRALIA WITH VICTORIA AND NEW SOUTH WALES.

By PIETRO BARACCHI, F.R.A.S.

Since the issue of the Report on Australian Longitudes, in 1885, further information has become available through the publication of various works, especially Vol. I. of the Annals of the Cape Observatory, and Vol. III. of the Dunecht Observatory Publications, relating to certain longitude determinations, upon which the Australian results partly depend.*

It was not expected that on this account the adopted values would have suffered any material modification; and even if such were found to be the case, the new values could hardly have been taken as final, knowing that several links in the long chain of connection between the prime meridian and Australia are regarded as weak, or at least capable of being strengthened.

On the other hand, opportunities for making fresh measurements along this chain seem remote, and we may probably have to be satisfied with what we have for some years to come.

This latter consideration induced me to examine the whole of the existing materials bearing on the subject, in order to form the most probable values of these longitudes, which may claim as their basis the full amount of evidence made known to the present date.

Since the telegraphic method was first introduced by the coast survey of the United States, its superiority to the older ones dependent on the motions of the moon, transportation of chronometers, &c., has been generally admitted. It is remarked by Professor Asaph Hall: (1) "The real probable error of a longitude found by means of moon culminations under the best conditions—that is, when the moon is compared with stars at both stations—amounts to two or three seconds of time."

Again, it has been shown by Dr. Gould (2) that the longitude of Washington, determined by transportation of chronometers across the Atlantic, and also by observations of moon culminations, occultations, and eclipses, which gave apparently consistent results, was found to be more than four seconds of time in error when compared with the telegraphic determination of 1867.

* NOTE.—For list of works consulted, see Appendix II.

In Australia, however, the results of 1883, found by exchange of galvanic signals, may be said to confirm those obtained in Melbourne, Sydney, and Windsor by lunar observations. For accepting the last values given by Dr. Auwers—(3) page 345 -which are based on the latter methods, the amount of discordance is only a fraction of a second of time.

The telegraphic method has in some instances produced astonishing results. The interval Greenwich-New York was measured three times in different years through different cables, and the three values obtained did not differ by more than one-hundredth part of a second —(4) page 181. But this is not to be taken as a typical example, for in the majority of cases the uncertainty of the results is much greater, often amounting to as much as half a second.

The last telegraphic measurement, Greenwich-Paris, in which the precautions to guard against error were equal to its importance, gave independent results differing by 0·4 seconds -(5).

Five independent measures of the interval Sydney-Melbourne vary in their extreme values by 0·6 second—(6) page 24. These, however, may be considered the limits of error in telegraphic operations of longitude, and the method may be assumed to give results generally true within much smaller amounts than those last mentioned. So that if it were feasible to exchange galvanic signals directly between Greenwich and Melbourne, provided that the signals occupied the same time in passing from one terminus to the other in both directions (a condition not yet ascertained in any case), we might be able to determine the position of an Australian meridian within a very small fraction of a second of time. But each interval measured is more or less affected by some error, and there are at least ten such intervals to consider between the prime meridian and the meridian of Melbourne. Therefore we must not too readily assume that we know our longitudes within 100 or 200 feet, even though such may be the amount indicated by the theoretical probable error. These considerations seem to point out very strongly that, in attempting to find out what values we are to adopt as the most probable from the many combinations that can be formed, it is advisable to take into account those derived from moon culminations and occultations. The American astronomers and others justly adopted the telegraphic values in preference to all others for their longitudes; but our conditions are different, and we have the fortunate circumstance that the older results based on absolute methods differ but a little from those of 1883, and that therefore the former cannot vitiate the latter to any appreciable extent.

The telegraphic operations to be considered for my purpose extend over a period of thirty-three years, and their records are necessarily scattered in several volumes, reports, and papers, some of which, as stated before, came to light only recently. They contain full accounts of the circumstances under which the work was carried out, show complete details of the observations and deductions in nearly every case, and for the intervals included between Greenwich and Aden the theoretical mean errors computed by Dr. Auwers and Dr. Gill are attached to the values therein adopted—(7).

It was my first care to collect all the independent values of intervals actually measured, and to compute their mean errors (if not already given) when possible or advisable. These are shown in Table I. The "mean error" was adopted in preference to the "probable error" in order to preserve uniformity with the first portion of the chain. The latter can be readily derived by multiplying the mean error by 0·6745.

It must be remembered that this theoretical error is only a measure of the agreement of the observations upon which a result depends, and therefore only a part of the absolute amount of uncertainty attached to that result.

In the next place, it was necessary to scrutinise the accounts in order to learn all the facts connected with the operations which might increase or decrease the reliability of the given results, such as instruments used, methods of recording the observations, conveniences in exchanging galvanic signals, quality of these signals, personal equation of observers, stability of stations, agreement of independent results where more than one measurement was made, &c., &c.

These circumstances will be here summarised and arranged for comprehensive inspection. There can be no definite rule to serve as a guide in their interpretation, nor can they be submitted to mathematical treatment. Their effect may be variously estimated by different investigators, and may sometimes be even misleading; but their influence upon conclusions found in regard to the degree of accuracy of results will nevertheless be easily recognised as being very great. At first I thought to take my start from Aden, since up to this point the longitudes have been thoroughly discussed and concluded by Dr. Auwers and Dr. Gill (7); but I find that the merits and defects of this part of the work, and all the separate results belonging to it, must be shown, in order to exhibit the complete chain from one point of view, so as to be able, and enable others, to weigh it as a whole, with the convenience of not having to refer to so many publications; and more especially because on the operations between Greenwich and Aden probably rest elements of doubt of a more serious character than in the more eastern portions, for, quoting Dr. Gill—(7) page 62—"Neither of the two series of operations on which the longitude of Aden depends was executed with such refinements or precautions as are necessary for the determination of fundamental longitudes." It must be mentioned, however, that these operations were chiefly undertaken in connection with the Transit of Venus observations, for which purpose their accuracy was sufficient.

I shall therefore commence at the beginning—viz., the prime meridian. The values of intervals, as given in Appendix, Table I., will be referred to by the letters respectively attached to them.

Longitude of Alexandria.—Six different values—viz., (*a*), (*b*), (*c*), (*d*), (*e*), and $\frac{1}{2}$ (f + f_1)—may be combined, giving three values for this longitude, two of which are quite independent.

(*a*) *Greenwich-Mokattam.*—This was determined by exchange of galvanic signals between Greenwich and Porthcurno; Porthcurno and Alexandria (by joining the five lengths of cable, Porthcurno, Vigo, Lisbon, Gibraltar, Malta, Alexandria); and finally, between Alexandria and Mokattam. Time observations were made with transit instruments at Greenwich, Alexandria, and Mokattam, but those at Alexandria were not used for this interval. The observers were Mr. Criswick at Greenwich, Mr. Ellis at Porthcurno, Mr. S. Hunter at Alexandria, and Captain C. Orde Brown, R.A., at Mokattam. Transits were recorded by eye and ear at these two latter places. All galvanic signals were sent by hand, and observed by eye and ear. The operations were executed in November, 1874, on the four nights, 14th, 15th, 21st, and 22nd. The personal equation in observing transits between Mr. Criswick and Captain Brown was determined before and after the longitude operations, and varied from 0·025 sec. to 0·655 sec.—(8) page 288.

(*b*) *Alexandria-Mokattam.*—(8) On the same four nights, 14th, 15th, 21st, and 22nd November, Mr. Hunter, at Alexandria, made transit observations with a portable transit instrument, in addition to exchange of signals with Mokattam. His station, which was on the roof of the Hotel de l'Europe, does not seem to have offered the necessary stability for delicate work. Dr. Gill remarks of this station—(7) page 63—"The observer had to abstain from movement during each complete observation, otherwise the level was disturbed by the change of his position." The personal equation of the two observers was determined after their return to England. At Alexandria the chronometer had to be carried to the telegraph office for exchange of signals, which was at a distance of about five minutes' walk.

(*c*) *Greenwich-Berlin.*—Result of several determinations—(9) page 490.

(*d*) *Berlin-Malta.*—Observers: At Malta, Dr. Löw, chief of the German Expedition of the Transit of Venus, 1874, to Mauritius; at Berlin, the astronomers of the Observatory, Drs. Becker, Auwers, and Knorre. Dr. Löw made time observations with a portable transit instrument, recording by the eye and ear. Galvanic signals exchanged by hand on six nights in 1875, March 10, 11, 12, 13, 14, and 15. Personal equation well determined. Signals satisfactory—(9) page 360-393.

(*e*) *Malta-Alexandria.*—Observers: Dr. Löw at Malta, Dr. Gill at Alexandria, same station as Mr. Hunter's. Dr. Gill made his time determinations with an altazimuth. Operations repeated on the nights of March 10, 11, 12, 13, and 14 (1875). Personal equation of these observers, well determined.

The chronometers had to be carried to the telegraph station for exchange of signals, as in the case of (*b*)—(9) page 306-320.

(*f*) *Berlin-Alexandria.*—Direct measurement made on February 28, March 6, 7, 10, 12, 13, and 14 (1875). Personal equations of the observers, known through Dr. Löw; the observers being Dr. Gill at Alexandria, and the astronomers of the Observatory at Berlin. This value was deduced by Dr. Copeland. It is remarked in (9) that the signals were unsatisfactory, and the combination of the two intervals (*d*) and (*e*) was adopted in preference of the direct value—(9) page 320-348.

(f_1) *Berlin-Alexandria.*—Same operations as in (*f*). Value deduced by Dr. Auwers—(7) page 60.

The three values for the longitude of Alexandria are—

	h.	m.	sec.
By the combination—$(a)-(b)$	1	59	33·69
$(c)+(d)+(e)$ ...	1	59	33·827
$(c)+\frac{1}{2}\{(f)+(f_1)\}$ ...	1	59	33·750

The following values were adopted, viz. :—

		h. m. sec.		Mean error.	
(9) page 491—					
By Dr. Copeland	...	1·59·33·807	mean 1·59·33·846	± 0·078	I.
(7) page 60—					
By Dr. Auwers ...	...	1·59·33·885			
(8) page 330—					
By British Transit of Venus Expedition	...		1·59·33·69	± 0·156	II.

The values I. and II. of the longitude of Alexandria are independent. Their difference is 0·156 seconds.

(*g*) *Alexandria-Suez.*—Observers: Dr. Löw at Suez, Dr. Gill at Alexandria. Instruments for time determination, same as already stated above. Galvanic signals exchanged on five nights—viz., 1875, February 19, 20, 23, 24, and 25. Signals sent by hand; observations made by eye and ear. At both stations the chronometers had to be carried for some distance to exchange signals. Result computed by Dr. Copeland—(9) page 492.

(g_1) *Alexandria-Suez.* — Same operations as in (*g*). Result deduced by Dr. Auwers—(7) page 60.

(*h*) *Mokattam-Suez.*—Observers: Mr. Hunter at Suez, Captain Brown at Mokattam. The instruments used by these observers have already been referred to in (*a*) and (*b*). The signals were sent by hand, and the observations made by eye and ear. Operations repeated on four nights—viz., 1874, December 4, 5, 7, and 14. The station used by Mr. Hunter was not the same as Dr. Löw's station. The former appears to have given trouble on account of its instability. It is remarked by Mr. Hunter—(8) page 333—"The only defect arose from the looseness of the soil, causing the level readings to vary a good deal." The same complaint is also made by the officers of the Great Trigonometrical Survey of India, who used this station in 1877—viz., that their observations may be somewhat vitiated by the unsteadiness of their instruments, due to looseness of the soil—(12) page 45*a*.

(*i*) Difference of longitude between Dr. Löw's and Mr. Hunter's stations at Suez.

This was determined by Dr. Gill by time observations made by himself with Dr. Löw's transit instrument mounted at one station, and with his altazimuth mounted at the other station, and by transportation of nine chronometers to and fro. The value thus found was 0·32 seconds—(9) page 262-266.

(i_1) The same interval as (*i*), determined by a traverse under the direction of Captain (now Colonel) Campbell, R.E.; its value was found to be 0·025 seconds—(9) page 491 and (11) Appendix to Part II., page 109. The discordance between the two above values is 0·295 seconds. This may be probably accounted for, or at least partly, by the length and complex character of Dr. Gill's operations, when compared with a simple traverse; and also by the circumstance remarked in (9) page 262, that "these operations required seven and a-half hours of continuous observing, involving great fatigue."

We have thus the two following independent values for the interval Alexandria-Suez, reduced to Hunter's station, by adopting value (i_1), viz:—

	h.	m.	sec.
$\frac{1}{2}\{(g) + (g^1)\} + i_1$ ...	0	10	39·025 ± 0·082
$(b) + (h)$	0	10	39·481 ± 0·160

which differ by 0·456 sec.

The value for Alexandria-Suez, deduced from the two above, weighted in terms of their respective mean error, is—

	h.	m.	sec.		
Interval Alexandria-Suez—	0	10	39·120 ± 0·073	...	III.

(*k*) *Suez-Aden.*—Observers: Dr. Löw at Suez, Dr. Gill at Aden. Time observations at Aden were made with some difficulty; in fact, "opportunities for observing were few and unsatisfactory"—(9) page 5. At Aden, the distance between the observing station and the telegraph office where signals were sent and received was nearly two miles. The operations were very limited, and the result depends on time observations of the single night of 31st January, and on the exchange of galvanic signals on the two nights of 30th and 31st January. This result was computed by Dr. Copeland—(9) page 196-227.

(k_{I}) *Suez-Aden.*—Same operations as in (*k*). Result given by Dr. Auwers—(7) page 61.

(k_{II}) *Suez-Aden.*—Observers: Captain (now Colonel) Campbell, R.E., at Suez; Captain (now Colonel) Heaviside, R.E., at Aden. Station at Suez the same as Mr. Hunter's. Station at Aden a few yards north of the cable offices at Telegraph Bay. These officers aimed at the highest refinement possible, and had at their disposal the necessary equipment and conveniences wherewith to attain their purpose—(11), Part I., Chapter I. Their transit instruments were of similar dimensions and workmanship (5″ object glass, with collimators, and means of levelling by mercury reflection, &c.) They recorded observations by chronograph. Galvanic signals were always exchanged directly between the stations, being sent by hand, and simultaneously recorded on both chronographs. Their operations were repeated on the six nights of 1877, May 25, 26, 27, 28, 29, and 30, giving very accordant results. Their personal equation was determined on four nights in April, 1877; and although it was not redetermined after the expedition, no serious consequences may be feared on that account. The observers themselves are confident that it remained fairly constant—(11), Part I., page 34. On the other hand, if their usual mode of observing was liable to sudden changes of considerable magnitude (of which there is no evidence), a redetermination after the expedition would have given very little help in finding the actual changes that took place at Suez and Aden. The only disadvantage in this measurement is to be attributed to the unsteadiness of the station at Suez, as already pointed out in (*h*)—(11), Part II.

(*l*) Difference of longitude between Dr. Gill's and Captain Heaviside's station at Aden.

This was determined by a careful triangulation, made under the direction of Captain Heaviside—(11) App., Part II.

We have, then, for the interval Suez-Aden reduced to Mr. Hunter's station at Suez, and Captain Heaviside's at Aden—

	h.	m.	sec.	sec.
$\frac{1}{2}\{(k) + (k_{\text{I}})\} - i_{\text{I}} - l$	0	49	42·839	± 0·120
(k_{II})	0	49	42·662	± 0·060

The difference between these two independent results is 0·177sec. Combining them according to their mean errors, we have—

	h.	m.	sec.	sec.		
Suez-Aden ...	0	49	42·697	± 0·054	...	... IV.

The longitude of Aden, reduced to Captain Heaviside's longitude station, may now be derived by combining the several values shown in the foregoing, in the manner adopted by Dr. Gill—(7) pp. 60-62—omitting the value given for Alexandria-Mokattam, viz.:—

By the British Transit of Venus Expedition of 1874, and the Officers of the G.T.S. of India.

	h.	m.	sec.	sec.
(*a*)	2	05	06·240	± 0·098
(*h*)	0	05	06·931	± 0·103
(k_{II})	0	49	42·662	± 0·060
A	2	59	55·833	± 0·154

By Lord Lindsay's Expedition of 1874 and Dr. Löw.

	h.	m.	sec.	sec.
I	1	59	33·846	± 0·078
$\frac{1}{2}\{(g) + (g_I)\}$	0	10	39·000	± 0·082
$\frac{1}{2}\{(k) + (k_I)\}$	0	49	43·742	± 0·120
(*l*) ... —	0	00	00·877	± 0
B	2	59	55·711	± 0·165

	h.	m.	sec.	sec.
A	2	59	55·833	± 0·154
B	2	59	55·711	± 0·165

Longitude of Aden (Captain Heaviside's station) 2 59 55·776 ± 0·113

Dr. Gill considered the mean errors of the two values A and B as equal, and adopted for the definitive longitude of Aden $\frac{1}{2}$ (A + B) (7) p. 62, viz.:—

	h.	m.	sec.	Probable error.	sec.
Aden E. of Greenwich	2	59	55·772	± 0·079	(should be 0·076?)

(*m*) *Aden-Bombay.*—Observer: Dr. Gill at Aden (Gill's station). The operations at Bombay were conducted under the direction of Mr. C. Chambers, Superintendent of the Colaba Observatory. Time at Bombay was determined by a transit instrument 5 feet focal length. Records made by chronograph. Time signals sent by hand, and observed by eye and ear at both stations. These operations took place in 1875, on 31st January, concurrently with the determination Suez-Aden by Drs. Gill and Löw; the time observations of this single night being all that could be secured at Aden. The personal equation between the observers not determined—(9) pages 182-195.

(m_I) *Aden-Bombay.*—Observers: Captain Campbell at Aden, and Captain Heaviside at Bombay. This measurement was made with the same instruments and methods described in (k_{II}). The station at Aden was the same as that occupied by Captain Heaviside in determining the interval (k_{II}). That at Bombay was 0·134 sec. east of the Colaba Observatory transit instrument. The operations were repeated on nine nights in 1877—April 30, May 1, 2, 3, 4, 5, 7, 8, and 9—giving accordant results.

The two values (*m*) and (m_I) are quite independent. The former is based on observations and conditions not altogether satisfactory (as we have seen), with very limited time and great disadvantages, and involving the unknown element of the personal equation of the observers. The latter value (m_I) is the result of elaborate operations extending over a period of nine nights, and made under the best possible conditions; yet these two results differ only by 0·03 sec.

(*n*) *Bombay.*—Difference of longitude between Captain Heaviside's station and the transit instrument of the Colaba Observatory. This was determined by a traverse measured under the direction of Captain Heaviside (11).

(*o*) *Bombay-Madras.*—Observers: Captains Campbell and Heaviside. Station at Bombay the same as that used for the interval (m_1). That at Madras was 65 feet due north of the transit circle of the Madras Government Observatory. This interval, though not determined directly, is certainly as well ascertained as any other—(11), Part I.

Its value is deduced from the telegraphic measurement of the difference of longitude of nine Indian arcs joining the six stations—Bombay, Bolarum, Bellary, Mangalore, Vizagapatam, Madras; the most direct route being Bombay-Bellary-Madras. (See diagram in (11) Part I., page 16.) The operations were executed by these officers in 1875-76-77 through the land lines, using the same instruments as mentioned in (k_{11}). Time signals were exchanged automatically, and simultaneously recorded at the two stations. Every possible precaution was taken to guard against error, systematic or accidental, and the work generally was carried out with a completeness that leaves nothing to be desired. The result for this interval is shown in (11) Preface to, Part I.; page (xviii.).

We are now enabled to deduce the longitude of Madras; but before doing so I shall mention and consider another set of totally independent operations, which must be regarded as a powerful check upon all others hitherto discussed—viz., the determination of the longitude of Madras, *viâ* Ispahan-Kurrachee. Indeed, if it were not for the very limited and somewhat incomplete observations at Kurrachee, and the undetermined personal equation of the observers at Ispahan and Madras, this chain would be entitled to much greater weight than the one *viâ* Suez-Aden-Bombay, because it connects Madras with Greenwich in four steps including only five stations, three of which are fixed national observatories, in addition to having the interval Kurrachee-Madras measured twice independently. I regret that, with the exception of the operations at Madras and Kurrachee, the details of the observations are not at hand; the results given here being taken from General Addison's paper -(10) page 83, and (13) pages 47, 54, 81. The actually measured intervals are as follow:—

(*p*) *Berlin-Ispahan.*—Observers: The astronomers of the Berlin Observatory, at Berlin; and Dr. Fritsch, chief of German Transit of Venus Expedition in Persia (1874), at Ispahan. The operations were repeated on eight nights—viz., November 16, 17, 18, 19, 20, 21, 23, and 27.

(*q*) *Ispahan-Kurrachee.*—Observers: Dr. Fritsch at Ispahan, and General T. Addison, C.B., at Kurrachee. General Addison observed for time with a portable transit instrument, and recorded his observations as well as galvanic signals by chronograph. Signals were exchanged on December 11 and 12, 1874. Personal equation between the observers not determined—(10) page 83.

(*r*) *Kurrachee-Madras.*—General Addison at Kurrachee, and Mr. Norman Pogson, Government Astronomer, at Madras. Galvanic signals were exchanged on one night only—viz., December 13. The time at Kurrachee depends on the observation of three stars. Results given by General Addison—(10) page 83.

(r_1) *Kurrachee-Madras.*—Same operations as in (*r*); value deduced by Mr. Pogson—(13) pages 47, 54, 81.

(r_{II}) *Kurrachee-Madras.*—This interval was determined indirectly through Bombay and Bellary and other Indian arcs by Captains Campbell and Heaviside in their usual excellent manner, as already spoken of. The operations were executed in 1880-81.

(s) Difference of longitude between General Addison's and Captain Campbell's station. The position of the former was 0·6 sec. east of the station "used in the Great Trigonometrical Survey at that place"—(10) page 84. The position of the latter is described in (11) Part I., page 252, as being 61 feet north, and 152 feet=1″·65=0·11 sec. west of the "Telegraph Office Station," which is a point "on the eastern terrace of the upper story of the block of dwelling quarters standing in the angle between Macleod road and Telegraph road, marked by a circle and dot engraved on the floor of the terrace, and connected with the Hill Stations A and Mutrani of the G.T.S." It seems, therefore, that the "Telegraph Office Station" is the one referred to by General Addison as being 0·6 sec. west of his observatory.

We may now compare the three values (r), (r_I), (r_{II}) of the interval Kurrachee-Madras, reducing them all to the Telegraph Office Station of the Great Trigonometrical Survey.

	sec.	h.	m.	sec.
(r)	+ 0·60 =	0	53	06·82
(r_I)	+ 0·60 =	0	53	06·45
(r_{II})	− 0·11 =	0	52	55·61

The two values (r) and (r_I) are derived from the same few and simple observations of a single night. Their difference is 0·37 sec., and has not been accounted for by the astronomers concerned. The value (r_{II}) is 11·21 sec. smaller than (r), and 10·84 sec. smaller than (r_I). This large error was pointed out in (6), page 31. No doubt some clerical mistake occurred somewhere, or the position of General Addison's station may be misunderstood; but to assume that this is a clerical error of ten seconds so as to make it a round number, as Mr. Pogson proposes—(13) page 81—seems arbitrary. It is strange that in all these years we have never heard an explanation of this matter.

The longitude of Madras is thus arrived at by two routes, as follows:—

Viâ Suez-Aden-Bombay.

	h.	m.	sec.	sec.
Longitude of Aden (Gill) ...	2	59	55·772	± 0·113
Aden-Bombay (m_I)	1	51	19·973	± 0·056
Bombay-Madras (o)	0	29	43·530	± 0·058
Longitude of Madras, VI. ...	5	20	59·275	± 0·139

Viâ Ispahan-Kurrachee.

	h.	m.	sec.	
(c)...	0	53	34·865	
(p)	2	33	05·44	
(q)	1	01	13·09	
$\frac{1}{2}\{(r) + (r_I)\}$	0	53	06·035	
Longitude of Madras... ...	5	20	59·430	... VII.

It would appear from result VII. that the error at Kurrachee vanishes in the sum of the two intervals Ispahan-Kurrachee and Madras-Kurrachee; in which case the results VI. and VII. compare very well indeed, considering that the unknown personal equation (Fritsch-Pogson) is involved in VII. I think, however, that this latter value may not be used for any further purposes at present. It would be difficult to do proper justice to it, even if favourable assumptions were made, which is always a dangerous course.

(t) *Madras-Singapore.*—Observers: Dr. J. A. C. Oudeman, Surveyor-General of Java, at Singapore; Mr. Pogson, at Madras. This measurement was made in July, 1871, by the exchange of galvanic signals through the cable, on the evenings of the 24th, 25th, 26th, and 28th. Mr. Pogson observed with the transit circle of the observatory and clock, but had to carry a mean time chronometer to the cable offices for exchange of signals at a distance of four miles. Dr. Oudeman made his time determinations on the 24th by observing zenith distances of two stars with a universal instrument. On the 25th and following dates the observations were made with a "broken transit instrument"—viz., one of the form in which the eyepiece is at one end of the horizontal axis. He also had to carry his chronometer to the cable offices for exchange of signals at a distance of three-quarters of a mile. Observations at both stations were made by eye and ear—no chronographs being used. The personal equation of the observers was not determined—(13) page 11, and (15) page 69. The point to which Dr. Oudeman referred his longitude was the position of the flagstaff on Fort Canning in 1871—see (15) page 69, and (14) page 211.

This result was deduced by Dr. Oudeman—(14) page 214.

(t_{I}) *Madras-Singapore.*—Same operations as in (t). Result given by Mr. Pogson—(13) pages 11-24.

(t_{II}) *Madras-Singapore.*—This determination was made by Lieut. Commander C. M. Davis, U.S.N., at Madras, and Lieut. John A. Norris, U.S.N., at Singapore, in 1882; the operations being repeated on the five nights of January 20, 21, 23, 26, and 27. These officers made their time observations with the so-called "broken transit instruments," which offer the great advantage that the observer remains in the same position during observations of stars at all altitudes—a condition greatly favouring the constancy of personal equation. They exchanged galvanic signals directly from their huts, thus avoiding the danger of having their chronometer rates accidentally disturbed, and errors of comparison. They had chronographs upon which their observations were recorded, and their personal equation was continuously tested by "absolute personal equation instruments," each observer being provided with one. This equation, however, was not introduced in the results, on account of its being always very small, and probably no greater than its possible variations. Cable signals were observed by reflecting galvanometers. The observers were especially well trained for that class of work, having made together many longitude determinations in various parts of the world. Their plans were all prearranged and methodically carried out, and the excellence of their results is shown in the agreement of values deduced from each night's observations. The discrepancy between the values (t) and (t_{II}) is 0·71 seconds, and that between (t_{I}) and (t_{II})

is 0·51 seconds. The Australian astronomers, in their report—(6) page 31—adopted the value (t_{11}), which course, considering the circumstances surrounding the two determinations of this interval, was no doubt the best.

(*u*) *Singapore to Port Darwin.*—This interval was determined in 1883, the observers being Captain (now Major) L. Darwin, R.E., at Singapore, and myself at Port Darwin. Captain Darwin made his time observations with the transit instrument previously used by the British Expedition of the Transit of Venus in New Zealand in 1882, and I observed with an excellent portable transit instrument (3½ inches object glass). The observations were recorded by chronograph. Galvanic signals were exchanged directly between the stations, sent by hand, and observed by reflecting galvanometer at each receiving observatory. Our personal equation was determined before the undertaking at Melbourne, and experiments were made at Melbourne and Sydney to test our mode of observing and transmitting signals. Three different methods were used in exchanging signals, in accordance with a plan proposed by Captain Darwin, which was strictly adhered to throughout. This plan is described in (6) page 26. The operations were repeated on the nights of February 13, 14, 15, 22, 23, 25, and 26.

The two cable lengths Singapore-Banjoewangie and Banjoewangie to Port Darwin were joined; and the signals, though passing through a distance of over 2,000 miles, were satisfactory when the circuit was good. On some occasions they appeared unsteady; but the greater attention then required in observing them seemed to compensate for their inferior quality, as the individual results show.

(*v*) Difference of longitude between the flagstaff on Fort Canning (position of 1871) and Lieut. Norris' station at Singapore in 1882. This latter is the same as that occupied by Captain L. Darwin in 1883. This value is given in (15) page 68, and was determined by measurement by Lieut. Norris. The flagstaff was west of Lieut. Norris' station. My station at Port Darwin was on the ground of the Eastern Extension Telegraph Company, 56 feet N. 40·22° E. of the veranda post at the north-east corner of the cable officer's quarters. It was marked by a masonry pillar 4 × 2 × 2 feet, upon which the transit instrument stood. This point is now the origin of the Australian longitudes (6).

(*w*) *Singapore-Banjoewangie.*—Observers: Captain Darwin at Singapore, and Captain H. Helb of the general staff, Batavia, at Banjoewangie. Captain Helb made his time determinations by observing zenith distances with a portable universal instrument. Galvanic signals were exchanged on February 17, 18, 19, 21, and 28, 1883. The personal equation between the observers was not determined—(6) page 29.

(w_1) *Banjoewangie to Port Darwin.*—This interval was determined by Captain Helb and myself. Signals were exchanged on four nights—viz., January 28, February 1, 22, and 23, 1883. Personal equation between the observers not known.

These operations were arranged at the request of the Dutch Government in order to verify the longitudes of Batavia. We were glad to have Captain Helb's co-operation, as it was not certain whether the direct signals between Singapore and Australia would be good enough for the purpose, and also as a check to our work. Captain Helb shortly after sent all his observations in detail over to Melbourne, where they were found in every respect excellent.

The two values (w) and (w_{I}) offer a partly independent value of the interval Port Darwin to Singapore, although the Banjoewangie longitude itself remains affected by the unknown personal equation of H. D. and B. The difference between the direct value (u) and the indirect one (w) + (w_{I}) is as follows, viz.:—

	h.	m.	sec.	sec.
(w)	0	42	06·78	± 0·076
(w_{I})	1	05	50·84	± 0·091
	1	47	57·62	
Personal equation (D.B)			02	
Singapore to Port Darwin (indirect) ...	1	47	57·60	± 0·119
Singapore to Port Darwin (direct) (u) ...	1	47	57·48	± 0·046

} Difference 0·12 sec.

These combined in terms of their mean errors give—

Singapore (Captain Darwin's station)—

	h.	m.	sec.	sec.	
Port Darwin	1	47	57·49	± 0·045	... VIII.

The longitude of Port Darwin may now be deduced, viz.:—

		h.	m.	sec.	sec.
Longitude of Madras	(VI.)	5	20	59·275	± 0·139
Madras to Singapore	(t_{II})	1	34	24·07	± 0·040
	(v)			1·51	±
Singapore to Port Darwin	(VIII.)	1	47	57·49	± 0·045
Longitude of Port Darwin	(IX.)	8	43	22·34	± 0·152

(x) *Port Darwin to Adelaide.*—Observers: Mr. (now Sir Charles) Todd at Adelaide, and myself at Port Darwin. The observations at Adelaide were made with the transit instrument of the observatory. The exchange of galvanic signals here consisted in sending clock-beats to each other automatically (generally two sets of two minutes each), which were simultaneously recorded on the chronographs at the two stations, the chronograph of the receiving station recording at the same time the beats of its own clock. The personal equation between the observers was determined on several occasions through Mr. E. J. White, then Chief Assistant at the Melbourne Observatory, and directly in Melbourne. The operations were repeated on six nights—viz., February 14, 15, 22, 23, and 26, and March 2, 1883—(6) page 22.

(y) *Melbourne-Adelaide.*—The operations for this interval were carried out at the two observatories under the direction of their respective Government Astronomers, Mr. Ellery and Mr. Todd. The observations were made by the latter at Adelaide, and by Mr. E. J. White at Melbourne. Clock-beats (generally two sets of two minutes each) were exchanged, and simultaneously recorded on the chronograph of both stations, &c., as in the case of the interval (x), Port Darwin to Adelaide. Personal equation between Messrs. Todd and White was determined several times. Comparisons made on five nights—viz., February 15, 17, 23, 26, and March 2 (1883).

(x_1) *Port Darwin to Melbourne.*—Observers: Mr. E. J. White at Melbourne, and myself at Port Darwin. The operations were exactly similar to those described in the two preceding intervals. Time signals were exchanged on four nights—viz., February 15, 23, 26, and March 2 (1883), the individual results being very fairly accordant. The personal equation between the observers was determined before and after the expedition—(6) page 22.

The value (x_1) ought to be equivalent to the sum of (x) and (y). We have, in fact—

	h.	m.	sec.	sec.
Adelaide to Port Darwin (x)	0	30	57·80	± 0·041
Melbourne to Adelaide (y)	0	25	33·84	± 0·050
Melbourne to Port Darwin, indirect ...	0	56	31·64	
Melbourne to Port Darwin (x_1) direct...	0	56	31·66	± 0·044

(z) *Sydney-Melbourne.*—This interval was measured five times by direct connection of the observatories between the years 1861 and 1884. The operations consisted, as usual, in the automatic exchange of clock-beats, producing chronographic records at the two observatories, and in time determinations made with the transit circles of these institutions, the whole under the direction of the respective Government astronomers. An indirect determination was made in 1868 through the longitude station at the western boundary of Victoria, of which more hereafter.

The last indirect measurement took place in 1887 through Mr. John Tebbutt, private observatory at Windsor, New South Wales. Mr. Tebbutt made his time determinations with a small transit instrument; sent his signals by hand from the local telegraph office, which is at a distance of (?) miles from his observatory, using a mean time chronometer, and observing the incoming signals by coincidence of beat. His operations were conducted with great care, and gave very satisfactory results.

The astronomers at Melbourne give great weight to the value of 1861, and to those of May and August, 1884. The mean of the five independent values is 24 min. 55·408 sec. The mean of the last two is 24 min. 55·395 sec., and that of 1861 is 24 min. 55·38 sec. The value 24 min. 55·40 sec. was adopted in (6) page 24 as the most probable. We may now conclude the longitudes of the three principal observatories east of Greenwich on the evidence of the telegraphic method alone, as follows, viz.:—

	h.	m.	sec.	sec.
Longitude of Port Darwin, IX.	8	43	22·34	± 0·152
Port Darwin to Adelaide Observatory (x) ...	0	30	57·80	± 0.041
Longitude of Adelaide Observatory, X. ...	9	14	20·14	± 0·157
Melbourne-Adelaide (y)	0	25	33·84	± 0·050
Longitude of Melbourne Observatory	9	39	53·98	± 0·165
Longitude of Port Darwin, IX.	8	43	22·34	± 0·152
Melbourne to Port Darwin (x_1)...	0	56	31·65	± 0·044
Longitude of Melbourne Observatory, XI. ...	9	39	53·99	± 0·158
Sydney-Melbourne (z)	0	24	55·40	± 0·091
Longitude of Sydney Observatory, XII. ...	10	04	49·39	± 0·182

LONGITUDE DETERMINATIONS IN AUSTRALIA, BY LUNAR OBSERVATIONS.

Dr. Auwers' investigation and discussion of these observations produces the following results, based on—

1st. Observations of moon culminations observed by the Rev. Dr. Scott, then Government Astronomer at the Sydney Observatory, in the years 1859-60, &c.

2nd. By observations of moon culminations made by Mr. H. C. Russell (now Government Astronomer at Sydney) in 1863-71-74, &c.

3rd. By observations of moon culminations made at Williamstown under the direction of Mr. Ellery, Government Astronomer of Victoria, in 1860-62.

4th. By observations of moon culminations made at Melbourne by Mr. E. J. White, chief assistant, under the direction of Mr. Ellery, in 1874-75.

5th. By observations of lunar occultations made by Mr. E. J. White, under Mr. Ellery's direction, at the Melbourne Observatory, in the years 1874-75.

6th. By observations of lunar occultations made by Mr. John Tebbutt at his private observatory, Windsor, New South Wales, in the years 1873-74-75-76, &c.

Dr. Auwers reduced all these observations to the longitude of Sydney by adopting the telegraphic values of the intervals Sydney-Windsor as 1 min. 28·83 sec., and Sydney-Melbourne as 24 min. 55·43 sec.; and found—(3) page 345:—

	h.	m.	sec.
Longitude of Sydney Observatory	10	04	49·60
" Melbourne Observatory	9	39	54·17
" Windsor (Mr. Tebbutt's Observatory)	10	03	20·77

We have seen that, on the strength of later determinations, the intervals Sydney-Windsor and Sydney-Melbourne are, respectively:—

h.	m.	sec.
0	1	29·43—(16) page 313.
0	24	55·40—(3) page 24.

Dr. Auwers' results must therefore be slightly modified, as follows, viz:—

	h.	m.	sec.
Longitude of Sydney by moon culminations—Scott	10	4	45·81
Longitude of Sydney by moon culminations—Russell	10	4	50·66
Longitude of Sydney by moon culminations—Mean	10	4	48·24 (i.)
Longitude of Melbourne by moon culminations at Williamstown and Melbourne+24 min. 55·40 sec.	10	4	50·08 (ii.)
Longitude of Sydney by moon culminations, $\frac{1}{2}\{(i.)+(ii.)\}$	10	4	49·16
Longitude of Windsor by lunar occultations observed by Mr. Tebbutt+1 min. 29·43 sec., with weight 5	10	4	50·68 (iii.)
Longitude of Melbourne by lunar occultations observed by Mr. White+24 min. 55·40 sec., with weight 1	10	4	48·52 (iiii.)
Longitude of Sydney by occultations $=\frac{1}{6}\{5\,(iii.)+(iiii.)\}$	10	4	50·32

	h.	m.	sec.
Longitude of Sydney by culminations, with weight 2	10	4	49·16
,, ,, occultations, with weight 1	10	4	50·32
,, ,, absolute methods ...	10	4	49·93
Longitude of Melbourne, by absolute methods ...	9	39	54·53

Taking the four values—(i.), (ii.), (iii.), and (iiii.)—and combining them with the weights assigned by Dr. Auwers, the mean error of the result is found to be 0·581 sec. We have then—

	h.	m.	sec.
Longitude of Sydney by absolute methods ...	10	4	49·93±0·581
Longitude of Sydney by telegraphic method (xii.)	10	4	49·39±0·182

which, being again combined with weights derived from their mean errors, give us definite longitudes based on all evidence available—

	h.	m.	sec.	
Sydney	10	4	49·44	(xiii.)
Melbourne	9	39	54·04	(xiv.)

The theoretical errors would show that the amount of uncertainty of the two methods is about as 1 : 3, a result not inconsistent with the estimation that might otherwise be made of their respective degree of accuracy, judging from the nature of the cases and the circumstances surrounding them, and not disparaging to those able astronomers who, by long and patient observations of the moon, gave to Australian longitudes values so closely accordant to those obtained by the easier and simpler system of galvanic signals.

EASTERN BOUNDARY OF SOUTH AUSTRALIA.

Boundary Line between South Australia and Victoria.—As the business of this paper is limited to assigning the most probable value and error to the longitude of the line actually marked on the ground, and proclaimed in the *South Australian Gazette* of 23rd December, 1847, to be the common boundary of the two colonies of South Australia and Victoria, it will not be necessary here to recapitulate the history relating to the determination of its geographical position. Suffice it to say that, in 1839, Mr. C. J. Tyers assigned a certain longitude to a point on the eastern entrance of the River Glenelg, based upon the longitude of the Parramatta Observatory (the only known longitude at the time), and determined differentially by transportation of chronometers to Melbourne, and by triangulation from Melbourne to the Glenelg, checking his work by lunar observations made with a sextant at Portland Bay; that in 1846 Mr. Surveyor Wade deduced from Tyers' determination what would be the position of the 141st meridian of east longitude from Greenwich, and actually marked this meridian on the ground, from the sea shore in latitude 38° 4′ 3″ to latitude 36°, and that the marking of the same line was continued northward to the River Murray, in 1849-50, &c.—(17).

Two points near the southern end of this line—viz., Pile No. 3 and Pile No. 4—were connected by Mr. A. C. Allan with the Trigonometrical Station at Mount Ruskin, whose geodetic longitude is deduced by triangulation from Melbourne. We are thus enabled to assign the most probable value to the longitude of the south end of the marked boundary, viz. :—

Longitude of Melbourne Observatory—(xiv.) 9h. 39m. 54 sec. 04=	144° 58′ 30″·60
Interval Mount Ruskin △ — Melbourne Observatory (by triangulation) ...	4 00 37 ·46
Longitude of Mount Ruskin △	140 57 53 ·14
Pile No. 3 on Boundary Line 301 feet S. 48° 10′ E. of Mount Ruskin △ ...	2 ·84
Longitude of Pile No. 3 on marked boundary between South Australia and Victoria	140° 57′ 55″·98
	=9h. 23m. 51s. 73 (xv.)

This shows that the southern end of the marked boundary between South Australia and Victoria is 2′ 04″ 02=9,921 feet=150 chains 32 links west of the 141st meridian of east longitude from Greenwich.

I may point out that in the plan showing the survey of the lower part of the Glenelg, issued by the Crown Lands Department of Victoria in November, 1874, the distance of the boundary near Mount Ruskin from the 141st meridian is given as 136 chains 63 links, or 13 chains 69 links less than the value deduced here.

BOUNDARY LINE BETWEEN SOUTH AUSTRALIA AND NEW SOUTH WALES.

In 1868 Mr. (now Sir Charles) Todd, co-operating with the Government Astronomers of Victoria and New South Wales, determined telegraphically through the Melbourne and Sydney Observatories the longitude of a point (to be referred to in these pages as the "Boundary Pier"), situated in latitude 33° 55′ 8″ S. and 25 chains 68 links W. of the north end of the marked boundary between South Australia and Victoria, for the purpose of deducing a more accurate position of the 141st meridian, which was to be adopted as the common boundary of South Australia and New South Wales. At the point in question Mr. Todd mounted a 4-feet transit instrument, and connected his temporary observatory with the telegraph line, which was about one-third of a mile away. He observed transits of previously selected stars on the nights of May 9, 10, 13, and 14, the first two being devoted to the interval Sydney-Boundary, and the others to the interval Melbourne-Boundary. The observed times of transit of each star over the nine wires of his telescope were transmitted by corresponding galvanic signals, made by hand with the ordinary observing key, and automatically recorded on the chronograph of the receiving observatory, where the same stars were observed at meridian passage, and the corresponding times recorded on the same chronograph.

These operations gave the following results, viz. :—

	h. m. sec.	
Interval, Sydney to Boundary Pier ...	0 40 59·718	(A^1)
„ Melbourne to Boundary Pier	0 16 03·767	(B^1)
„ Melbourne-Sydney (indirect)	0 24 55·951	(C^1)

The interval Sydney-Melbourne, as previously mentioned, was also determined directly on 3rd April, 1868, by exchange of galvanic signals between the observatories. The signals sent by Sydney to Melbourne were transits of fifteen stars (previously selected), observed in turn by Messrs. Smalley, Russell, and Todd, with the Sydney transit circle.

These signals were automatically recorded on the chronograph at Melbourne, together with the times of transit of the same stars observed by Mr. White at meridian passage at the latter place. The signals sent by Melbourne to Sydney were simply clock-beats.

The result of these operations, gave—(17)—

Interval, Sydney-Melbourne (direct) 0 hr. 24 min. 55·81 sec. (D^1)

The values (C^1) and (D^1) differing only by 0·14 sec., the results from the operations of 1868 were readily accepted as entirely satisfactory. The adopted longitude of Sydney, from which Mr. Todd deduced the position of the 141st meridian, was—(17)—

10 hr. 04 min. 48·97 sec.

The boundary between South Australia and New South Wales was accordingly fixed at a distance of 2 miles 44 chains 68½ links from Mr. Todd's station, measured by him and Mr. A. B. Cooper, Deputy Surveyor-General of South Australia, along a line run due east from the centre of the Boundary Pier. It was also found that the marked boundary between South Australia and Victoria, when prolonged to the north of the Murray, intersected this easterly line at a distance of 25 chains 68 links from the centre of the said pier—(17).

I must now remark that the values (C^1) and (D^1) compare unfavourably with the other five direct determinations of the interval Sydney-Melbourne, being the largest of them all, and differing from their adopted mean—(6) page 24—by 0·55 sec. and 0·41 sec. respectively.

This discordance of more than half a second of time will necessarily be felt in full in the deduction of the longitude of the Boundary Pier, and consequently of the actually marked boundary lines, as the most probable value of the interval Sydney-Melbourne, as far as can be known at present, and also the one already adopted—(6) page 24—is—

0 hr. 24 min. 55·40 sec.

It is much to be regretted that the operations of 1868 were so very limited, considering the importance of the results expected from them. Value (D^1) rests, in fact, on the observations of a single night, made by four different observers, three of whom, as we have seen, observed transits with the Sydney transit circle in turn. It must also be noted—1st. The signals exchanged were of a different nature, being sent by the observer in one direction, and by the clock in the other. 2nd. The constancy in personal equation may have been greatly disturbed by the unusual circumstances surrounding the observations at Sydney. 3rd. The signals at the boundary were sent in one direction only. This may probably involve a very small error only; but there is no direct proof that such error is negligible. It may, indeed, be considerable in the case of the interval Sydney-Boundary, with 900 miles of wire, indifferent circuit, and difficulty in adjusting the electric apparatus, causing the record of many signals sent by the Boundary Observatory to be lost in Sydney. [See (17).] This interval, Sydney-Boundary, is deduced from observations of six stars on May 9, and four stars on May 10. The interval, Melbourne-Boundary, depends on the observations of nine stars on May 13, and twelve stars on May 14; the circuit in this case being excellent on both nights.

The mean errors, computed from the agreement of the observations, give weights nearly equivalent to those assigned by Mr. Todd.

The intervals Sydney to Boundary Pier and Melbourne to Boundary Pier, combined with the adopted longitudes of Sydney and Melbourne, and with the measured distances of the two boundary lines from Mr. Todd's station, will give the longitudes of these lines, thus—

Viâ Sydney.

		h.	m.	sec.	sec.
Longitude of Sydney Observatory ...	(XIII.)	10	04	49·44	± 0·174
Interval Sydney to Boundary Pier ...	(A¹.)	0	40	59·72	± 0·076
Longitude of Boundary Pier	(XVI.)	9	23	49·72	± 0·190
Distance from Pier to Marked Boundary of South Australia and New South Wales	...	0	0	10·68	
Longitude of the Boundary between South Australia and N. S. Wales	(XVII.)	9	24	00·40	± 0·190

		h.	m.	sec.	
Longitude of Boundary Pier	(XVI.)	9	23	49·72	
Distance from Pier to Marked Boundary of South Australia and Victoria	...	0	0	1·34	
Longitude of the north end of the common Boundary of South Australia and Victoria	(XVIII.)	9	23	51·06	± 0·190

Viâ Melbourne.

		h.	m.	sec.	sec.
Longitude of Melbourne Observatory	(XIV.)	9	39	54·04	± 0·153
Interval Melbourne to Boundary Pier ...	(B¹.)	0	16	03·77	± 0·050
Longitude of Boundary Pier	(XIX.)	9	23	50·27	± 0·161
Distance from Pier to Marked Boundary of South Australia and New South Wales	...	0	0	10·68	
Longitude of the Boundary line between South Australia and New South Wales	(XX.)	9	24	00·95	± 0·161
Longitude of Boundary Pier	...	9	23	50·27	± 0·161
Distance between Pier and north end of Boundary between South Australia and Victoria	...	0	0	1·34	
Longitude of north end of Marked Boundary line between South Australia and Victoria	(XXI.)	9	23	51·61	± 0·161

We found previously—

Longitude of south end of Marked Boundary between South Australia and Victoria	(XV.)	9	23	51·73	

Mean Values.

By combining (XVI.) and (XIX.) according to their mean errors, we have—

		h. m. sec.
Longitude of Boundary Pier		9 23 50·04
Longitude of Boundary between South Australia and New South Wales ...		9 24 00·72
Longitude of north end of Marked Boundary, South Australia and Victoria	(XXII.)	9 23 51·37

The two values (XV.) and (XVIII.) differ by 0·67 sec.—that is, they make the longitudes of the north and south end of the marked Victorian boundary line with South Australia differ by that amount. If we take instead the mean values (XV.) and (XVII.), the difference is reduced to 0·36 sec.; and if the value (A^1) of the interval Sydney to Boundary Pier be excluded altogether, using only the value (B^1) of the interval Melbourne to Boundary Pier, the difference is further diminished to 0·12 sec.; a quantity sufficiently small to admit a proper adjustment of both ends of the line without vitiating its longitude. We see then that the introduction of the value (A^1) into the final deduction of results would cause the south end of the boundary line to appear 500 or 600 feet further east than the northern end.

The anomaly might be explained in various ways.

First, by assuming an accumulated error in the Victorian triangulation, or some defect in the dimensions of the ellipsoid on which its calculations are based, causing the difference of longitude Melbourne to Mount Ruskin to be some 10 seconds too small. Such assumptions, however, are in the present state inadmissible, as the records of the survey do not show any such error on the one hand, and on the other it may be said that the operations of 1868 at the boundary were not sufficiently complete to serve as a test to the trustworthiness of geodetic measurements.

Second, by great carelessness in the marking of the boundary line—a supposition which could only be made on the very difficult condition of having every other probable source of error clearly and absolutely eliminated. I have no knowledge as to the means by which the line was marked, but it would require nothing less than direct evidence to show that its direction is wrong by 600 feet.

Third, by considering the value (B^1) of the interval Melbourne-Boundary too large by over half a second of time. In this case the true meridianal direction of the Boundary would be maintained, and the adopted value of the difference of longitude Sydney-Melbourne would receive further proof of its accuracy; but then the geodetic arc (Melbourne to Mount Ruskin) would become affected by a large error—a condition already refuted; and, moreover, the superiority of the value (B^1), as admitted by Mr. Todd in 1868, when he assigned to it double the weight of the value (A^1) [see (17)], would have to be arbitrarily inverted.

There remains only one way of explaining the discrepancy, and only one solution of the difficulty—viz., by taking the value (A^1) of the difference of longitude Sydney-Boundary as being considerably too large, and to exclude it from the Boundary results, in order to produce a general agreement, without fear of vitiating the absolute longitudes of the boundaries.

In justification of such procedure, it is simply submitted that one of the two measures (A^I) and (B^I) of the intervals Sydney to Boundary Pier and Melbourne to Boundary Pier is probably in error to the extent of about half a second of time; that the value (B^I) of the one is corroborated by the geodetic difference of longitude Melbourne to Mount Ruskin, and by the assumption that the marked boundary between South Australia and Victoria is a true meridian; and, finally, that the less reliability of the value (A^I) of the other was recognised at the time of its determination, which appears all the more reasonable in view of the probable causes of uncertainty already pointed out in these pages.

I shall therefore deduce the longitudes of the eastern boundaries of South Australia by adopting the last course. We have then—

Adopted longitude of the marked boundary between South Australia and Victoria—

$\frac{1}{2}\cdot\{(XV.) + (XXI.)\}$ ... 9 hr. 23 min. 51·67 sec. = 140° 57′ 55·0″

Adopted longitude of the boundary between South Australia and New South Wales, as fixed by Mr. C. Todd in 1868 9 hr. 24 min. 01·01 sec. = 141° 00′ 15·1″

At the Murray River—

The boundary between South Australia and Victoria is 10,535 feet west of the 141st meridian of east longitude from Greenwich;

The boundary between South Australia and New South Wales is 1,273 feet east of the 141st meridian of east longitude from Greenwich.

PROBABLE AMOUNT OF UNCERTAINTY OF THE AUSTRALIAN LONGITUDES.

It remains now to be seen with what degree of confidence the given results may be taken.

The theoretical errors attached to the longitudes of Adelaide, Melbourne, and Sydney, found above, are respectively ±0·157 sec., ±0·158 sec., and ±0·182 sec. It has already been stated that these errors represent only that part of the probable uncertainty due to the disagreement of separate results of the same measure derived from each night's work, when compared with their mean value. It would appear then that the really and purely accidental errors incurred in each single night of the period upon which a longitude result depends are fairly measured by the theoretical errors; or, if this measure is not quite satisfactory, is at least the best that can be obtained. But there may be involved systematic errors common to all the nights of that period, some of which are beyond the reach of investigation, and others that might possibly be discovered only by delicate and continued experiments in fixed institutions, but not in the temporarily arranged longitude observatories.

Altered personal equations at each new place of observation, instrumental changes, flexure, physical peculiarities of the localities, and many other known and unknown causes may bring in systematic errors not easily discovered. The theoretical error has no concern in these matters, and gives no help. It is when new instruments and new observers are employed in different years, so as to make the redeterminations entirely independent, that the existence of these systematic errors is revealed, if the results do not agree. But even then it is difficult, if not sometimes impossible, to locate them. There are, besides, inaccuracies the causes of which are traceable, such as unsteadiness of stations, imperfect adjustment of electric instruments, changeable strength of circuits, level imperfections, unfavourable conditions such as having to carry time pieces to a distance, and others; but their effect can only be made evident by new measurements.

Every determination of differential longitude, however short the interval may be, is weakened by at least some of the causes here enumerated.

Admitting consummate skill in the great majority of the observers concerned, we may then look at the conditions under which this long longitude chain Greenwich-Australia was developed, in order to see where its deficiency in strength is more especially to be feared.

There appears to be at first a natural division at Aden. The three intervals on the western portion were all measured twice, the results giving, as we have seen, the following discordances:—

	sec.
Greenwich-Alexandria	0·156
Alexandria-Suez	0·456
Suez-Aden	0·177

Indeed, remembering the circumstances, these differences seem very small. Yet, although the aggregate error in the Aden longitude may not be more than one-fifth of their sum, it would not be unreasonable to suspect that it may amount to half a second of time or even more, for the unsteadiness of the stations at Alexandria and Suez and the great variations in the personal equation of the observer at Mokattam are serious matters.

The operations east of Aden all along to Australia were decidedly made under better conditions and with more complete equipments, and, unlike the others (which were only chiefly made for the purposes of the observations of the Transit of Venus), they were intended for the establishment of fundamental longitudes.

The portion from Aden to Madras depends on the elaborate and refined operations of the officers of the Great Trigonometrical Survey of India, of which the interval Aden-Bombay, with its two independent and extremely accordant values, obtained under such uneven share of advantages, offers a remarkable instance of how a good result is sometimes found where we might be justified by the nature of the case in giving it but little weight.

From Bombay to Madras the telegraphic results, though in every respect highly trustworthy, are not corroborated by any other entirely independent telegraphic determination. It appears also that the geodetic value of this interval, derived from the principal triangulation, is $12''\cdot29 = 0\cdot819$ sec. in excess of the telegraphic value, the difference being partly attributed to local attractions—(11) Preface, page xviii.

Up to this point we have another test for the whole of the operations in the longitude chain *viâ* Berlin-Ispahan-Kurrachee, and but for the doubts attached to the Kurrachee station this test would be invaluable.

We have now the determinations Madras-Singapore of 1871 and 1882. It is not unfair to assume the superiority of the latter value. The chief weakness of the earlier one arises, perhaps, in the carriage of the chronometers to considerable distances for the exchange of signals, and in the unknown personal equation of the observers. There is a difference of more than half a second of time between the two results, and it is not quite certain, though most probable, that the whole of this error is attributable to the observations of Dr. Oudeman and Mr. Pogson.

The interval Singapore to Port Darwin depends solely on one set of operations—viz., those of 1883. I can only say that the observers felt satisfied about the quality of their work; but still the receiving of galvanic signals by observing the sudden motion of a beam of light not always regular or well-defined involves greater uncertainty than transit observations, and may be subject to comparatively large variations in its amount. The result is partly checked by the two separate intervals formed by the intervention of Banjoewangie, but is not corroborated by entirely independent operations. The difference between the direct and indirect result is 0·12 sec.

There remain now the Australian operations. In the two intervals Port Darwin to Adelaide and Port Darwin to Melbourne the unknown error of the results rests almost entirely on the time determinations at Port Darwin, as the exchange of signals was entirely automatic, and transit observations at the fixed observatories involve very little uncertainty.

The various measurements of the interval Sydney-Melbourne, as we have repeatedly observed in these pages, range from 24 min. 55·10 sec. to 24 min. 55·81 sec., which may give reason to suspect some unknown disturbing cause interfering with this kind of work. Fortunately, fresh determinations may be frequently repeated without inconvenience, and I believe it is the intention of the Government Astronomers of these colonies to make arrangements for that purpose.

We have, finally, the boundary longitudes.

Here an error of more than half a second of time was disposed of in what was thought the only possible way under the circumstances; but it does not by any means clear the doubts attached to the discrepancies produced by the operations of 1868.

These are the principal facts upon which an opinion is to be formed as to the amount of uncertainty inherent to the adopted results.

I think that the longitudes of the Australian Observatories may be accepted as true only within one second of time; and those of the boundary lines of South Australia with Victoria and New South Wales, within 1,500 feet.

POSSIBLE IMPROVEMENTS OF THE ADOPTED VALUES.

No doubt, even with the present means of astronomical science, the Australian longitudes could be strengthened by a new determination of the longitude of Aden, as recommended by Dr. Gill, and of the interval Ispahan-Kurrachee. The importance of these operations could not be overrated, and it is to be hoped that they will be undertaken at the first opportunity.

APPENDIX.

TABLE I.

Reference Letter.	Difference of Longitude.	Computed Mean Error.	Description of Interval for which the Difference of Longitude is given.
	h. m. sec.	sec.	
(a)	2 05 06·240	±0·098	Greenwich-Mokattam (Cairo).
(b)	0 05 32·550	±0·122	Alexandria (Hunter's Station) to Mokattam.
(c)	0 53 34·865	——	Greenwich-Berlin (Transit Circle).
(d)	0 04 28·316	±0·058	Berlin-Malta.
(e)	1 01 30·646	±0·030	Malta-Alexandria.
(f)	1 05 58·750	±0·078	Berlin-Alexandria. Dr. Copeland's Value.
(f_1)	1 05 59·020	±0·078	Berlin-Alexandria. Dr. Auwer's Value.
(g)	0 10 38·923	±0·082	Alexandria (Hunter's Station) to Suez (Löw's Station). Dr. Copeland's Value.
(g_1)	0 10 39·078	±0·082	Alexandria (Hunter's Station) to Suez (Löw's Station). Dr. Auwers' Value.
(h)	0 05 06·931	±0·103	Mokattam-Suez (Hunter's Station).
(i)	0 00 00·320	——	Suez (Hunter's Station, east of Löw's Station) to Dr. Gill's Determination.
(i_1)	0 00 00·025	——	Suez (Hunter's Station, east of Löw's Station) to Captain Campbell's Traverse Measurement.
(k)	0 49 43·750	±0·120	Suez (Löw's Station) to Aden (Gill's Station). Dr. Copeland's Value.
(k_1)	0 49 43·733	±0·120	Suez (Löw's Station) to Aden (Gill's Station). Dr. Auwers' Value.
(k_{11})	0 49 42·662	±0·060	Suez (Hunter's Station) to Aden (Heaviside's Station).
(l)	0 00 00·877	±0·	Aden (Gill's Station, east of Heaviside's Station.)
(m)	1 51 18·940	±0·	Aden (Gill's Station) to Bombay (Chamber's Station, Colaba Observatory).
(m_1)	1 51 19·973	±0·056	Aden (Heaviside's Station) to Bombay (Heaviside's Station).
(n)	0 00 00·134	——	Bombay to Captain Heaviside's Station (east of the Colaba Observatory Transit Instrument or Chamber's Station).
(o)	0 29 43·530	±0·058	Bombay (Heaviside's Station) to Madras (Observatory Transit Circle).
(p)	2 33 05·440	±	Berlin-Ispahan.
(q)	1 01 13·090	±	Ispahan-Kurrachee (Addison's Station).
(r)	0 53 06·220	±	Kurrachee-Madras (Addison and Pogson). General Addison's Value.
(r_1)	0 53 05·850	±	Kurrachee-Madras (Addison and Pogson). Mr. Pogson's Value.
(r_{11})	0 52 55·720	±	Kurrachee (Captain Campbell's Station) to Madras Observatory. Determination by the officers of the G.T.S.
(s)	0 00 00·710	±	Kurrachee (Campbell's Longitude Station, west of Addison's Station).
(t)	1 34 23·365	±	Madras (Observatory) to Singapore (Flag Staff on Fort Canning, 1871). Prof. Oudeman's Value.
(t_1)	1 34 23·560	±	Madras (Observatory) to Singapore (Flag Staff on Fort Canning, 1871). Mr. Pogson's Value.
(t_{11})	1 34 24·070	±0·040	Madras (Observatory) to Singapore (Lieut. Norris' Station).
(u)	1 47 57·480	±0·046	Singapore (Lieut. Norris and Capt. Darwin's Station) to Port Darwin (Baracchi's Station).
(v)	0 00 01·510		(Lieut. Norris' Station is the same as Capt. Darwin's Station). (Darwin's Station, east of Flag Staff on Fort Canning, 1871).
(w)	0 42 06·780	±0·076	Singapore (Darwin's Station) to Banjoewangie (Capt. Helbs).
(w_1)	1 05 50·840	±0·091	Banjoewangie (Helbs' Station) to Port Darwin (Baracchi's Station).
(x)	0 30 57·800	±0·041	Port Darwin (Baracchi's Station) to Adelaide Observatory).
(y)	0 25 33·840	±0·050	Melbourne (Observatory) to Adelaide (Observatory).
(x_1)	0 56 31·660	±0·044	Port Darwin (Baracchi's Station) to Melbourne Observatory).
(z)	0 24 55·400	±0·091	Sydney (Observatory) to Melbourne (Observatory).

II.—List of Works Consulted.

(1.) Report on the Determination of Differences of Longitude in the West Indies and Central America. By Lieut. Commander F. M. Green, U.S.N.
(2.) Smithsonian Contributions to Knowledge, No. 223, vol. 16.
(3.) Astronomische Nachrichten, No. 2636.
(4.) United States Coast Survey Report, App. 18.
(5.) Royal Astronomical Society, vol. 51.
(6.) Report on the Telegraphic Determination of Australian Longitudes, *viâ* Singapore, Banjoewangie, and Port Darwin.
(7.) Annals of the Cape Observatory, vol. i., Part II. (Dr. Gill.)
(8.) Account of Observations of the Transit of Venus of 1874. (Edited by Sir George Airy.)
(9.) Dunecht Observatory Publications, vol. iii. (By the Earl of Crawford and Balcarres.)
(10.) Royal Astronomical Society, vol. 38. (General T. Addison, C.B.)
(11.) Account of the Operations of the Great Trigonometrical Survey of India, vol. ix. (General J. T. Walker, C.B., R.E., F.R.S., &c.)
(12.) Report of the Great Trigonometrical Survey of India for 1876-77.
(13.) Telegraphic Determinations of the Difference of Longitude between Karachi, &c., and the Government Observatory, Madras. (By Norman Pogson, C.I.E., F.R.A.S., &c., Government Astronomer.)
(14.) Astronomishe Nachrichten, No. 2486. (Prof. F. A. C. Oudemans.)
(15.) Telegraphic Determination of Longitudes in Japan, China, &c. (By Lieut. Commanders F. M. Green and C. H. Davis, and Lieut. J. A. Norris, U.S.N.)
(16.) Royal Astronomical Society, vol. xlviii. (By Mr. John Tebbutt, F.R.A.S., &c.)
(17.) Report on the Determination of the Boundary Line of Colonies of South Australia and New South Wales. (By Charles Todd, F.R.A.S., Observer and Superintendent of Telegraphs, South Australia, 14th December, 1868.)

2.—TRANSIT OF MERCURY, 1894, November 11.—*Egress.*

By J. P. THOMSON, F.R.S.G.S., &c.

The instrument used to observe the Transit of Mercury was an equatorially-mounted refracting telescope, 6 feet focal length, with object glass 6 inches in diameter, built by Sir Howard Grubb in 1884. It is the property of Mr. F. D. G. Stanley, F.R.I.B.A. The telescope rests on a hollow cast-iron column, 5 feet 9 inches in height and 18 inches diameter at the base, in which is placed the driving clock. The whole metal work is mounted on a stone and concrete foundation carried down to the solid rock 6 feet below the surface of the ground, perfect freedom from vibration being thereby secured. The observatory, which is situated at Ardencraig, Toowong, the private residence of Mr. Stanley, is a wooden building 12 feet square, with roof arranged so as to roll entirely off on a railway and framing built to receive it. There can be no doubt whatever that in a fine climate this arrangement possesses many advantages to which I shall refer later on. Included in the equipment of the observatory is a transit instrument by Carl Bamberg, of Berlin (1879). This is placed upon a stone pedestal. The observations are taken through the hollow central axis of the instrument, the eyepiece being fitted with micrometer. A magnifying power of 100 diameters was used in the equatorial for the actual observation of the transit, this having been found, after repeated tests, to give the most perfect definition. The object glass of the telescope was stopped down to 3 inches.

The party consisted of His Excellency General Sir Henry Wylie Norman, Governor of Queensland, Messrs. F. D. G. Stanley and Arthur Cleminson (of the Surveyor-General's staff), time recorders, and myself, who observed the transit. There were three chronometers used—namely, No. 542, mean time, by Frodsham, in charge of His Excellency the Governor; No. 2139, also mean time, by Arnold, in the hands of

Mr. Stanley; and No. 4230, siderial, by Kullberg, under the care of Mr. Cleminson. The first belongs to Mr. Stanley's observatory; but the others, one of which is the property of the Hon. A. C. Gregory, were duly compared with the standard clock at the Brisbane city observatory for several days previous, and late on Saturday night, immediately before Mr. Cleminson and I transported them to Toowong, the former gentleman finally checked them by meridian stars. After the transit had been observed the chronometers were at once returned to the city observatory and re-compared. No. 4230 was found to have undergone no change whatever in transit, but there was a very slight displacement observed in the rate of the mean time chronometer. This recalls to my mind a similar experience at the time I was preparing to observe the Transit of Venus at Levuka, Fiji, in 1882. On that occasion three chronometers were also rated, although only one, the best, was actually used to record the times of the observations. Some two weeks before the date of the transit they were transported with the greatest possible care for a very short distance from the harbour master's office to the observatory, when it was found that a very slight change of rate had taken place.*

Weather.—Shortly after 5 o'clock the sun rose above a clear horizon, free from the slightest trace of haze. The whole sky was cloudless, the weather nearly a dead calm, and the atmosphere almost phenomenally steady and agreeably warm. A few preceding days of fine clear dry weather had happily dissipated the moisture accumulated in the atmosphere during previous daily showers, and thus we were privileged to conduct the observations under the most favourable conditions, in every respect typical. After considerable experience in astronomical work, I can honestly state that in no climate have I ever conducted astronomical observations under more favourable atmospheric conditions than those prevailing at Brisbane on the morning of 1894, November 11. A fair idea of these may be conveyed by stating that from sunrise till shortly before the internal contact the planet appeared against the solar surface as a clear and sharply defined disc through a small portable telescope which Mr. Stanley had placed outside the observatory door; and Mr. C. B. Lethem, observing with a 5-inch theodolite at Clayfield, some six miles north-east of our position, was able to record the interval of time between internal and external contacts, by an ordinary watch, to within seventeen seconds of the calculated interval. I have purposely emphasised this description of the weather, having long ago arrived at the conclusion that the so-called black drop and other somewhat remarkablo phenomena associated with the observations of the transits of planets are terrestrial causes and not celestial. In other words, they arise from unfavourable atmospheric conditions, from telescopic defect, and from some peculiarity in the physical condition of observers—either one or all combined. This subject has, I may state, been very ably elucidated by the distinguished astronomer, Mr. H. C. Russell, in a valuable paper upon a previous Transit of Mercury contributed to the Royal Society of New South Wales, 7th December, 1881. My own experience entirely confirms the views advanced by Mr. Russell.

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* Proceedings and Transactions of the Royal Geographical Society of Australasia, Queensland, vol. vii., p. 93.

The Observations.—At 5 hours 10 minutes the equatorial was pointed to the sun. The several small clusters of spots which had been observed on the solar surface for some few days previous were clearly visible as the sun gradually cleared the neighbourhood of the horizon. There was no difficulty whatever in distinguishing the planet, for Mercury at once appeared in the field as a most perfect sphere, intensely black, with remarkably clear and sharply-defined periphery. For some time I sat intently watching this interesting object as it slowly moved across the great solar surface. Particular attention was given to an examination of the effect of different magnifying powers and of various intensities of light by a manipulation of the combination of dark glasses used in the eyepiece of the telescope, but this produced no change whatever in the appearance of the planet. The definition was perfect, and there was not the slightest trace of haze, band of light, or vaporous aureola around the disc of Mercury. Attention was next bestowed upon a very minute white spot that appeared upon the surface of the planet. I was aware that a similar object had been noticed by several observers during previous transits, although I had failed to see anything of the kind at the transit of 1881, which I observed with a small telescope under distressing conditions. In this instance the steady unchangeable appearance of the object left no doubt in my mind whatever that it was something more tangible than an optical illusion. I removed the lower magnifying power, and applied one of 450 diameters, and at first thought I saw *two* white spots close together; but after the eye had accommodated itself to the change the second spot assumed a very uncertain appearance, and for this reason I doubt its existence altogether; the first, however, remained unchanged. When about to observe internal contact I was somewhat startled by what appeared for the moment to be a slight indication of ligament, but the phenomenon was only momentary, and I regard it as purely optical. When external contact occurred the limb of the sun and that of the planet were remarkably clear, sharp, and well defined. There was not the slightest trace of disturbance in the limbs of the two bodies, and I have every confidence in recording the phase as a pure geometrical contact. *Contact géométrique sans déformation.* I very carefully watched for the planet when it separated from the sun, but no trace of its periphery could be distinguished from the dark space beyond.

Taking the mean of the three chronometer records, the following are the corrected times of the observations, viz:—

	h.	m.	sec.
Internal contact	7	23	42·45
Geometrical external contact ...	7	25	28·00

The above are the mean times at Brisbane observatory, in latitude 27° 28′ ·00″ S., and longitude 10 hr. 12 min. 06·4 sec. E. We occupied a position of about 6,534 feet south and 10,428 west of the Brisbane observatory.

Regarding Mr. Stanley's observatory it will probably be found in general practice that a telescope is capable of doing better work when placed within a building with the roof entirely off than in one enclosed by the common revolving circular dome. In the former the air currents are more likely to be nearly uniform in temperature, while in the latter type opposing currents of air of unequal temperature are apt to materially influence definition. It is not, I believe, an extremely high nor abnormally low temperature an observer need fear, but unsteady and constantly changing air currents, within the observatory as well as without, that are inimical to good telescopic work. Once modify or minimise these conflicting elements, maintain uniformity of temperature in the observatory, and the results of astronomical observations will probably rise 50 per cent. nearer the truth than at present.

In conclusion, I have great pleasure in acknowledging the efficient aid rendered by the three gentlemen with whom I was associated in this work, and of testifying to the satisfactory degree of accuracy of the times recorded by them.

3.—DESIGN FOR A PHOTOGRAPHIC TRANSIT CIRCLE.

By H. C. RUSSELL, B.A., C.M.G., F.R.S., Government Astronomer, New South Wales.

The idea of making an instrument to record by means of photography the meridian passage of stars is not a new one, and several instruments have been designed for the purpose. All that I have seen described are attachments to the ordinary transit circle, and they seem to me to fall short of what is required from an instrument made for this purpose, because with such an arrangement it would be impossible to record faint stars, and the means for determining the right ascension are not so satisfactory as we have a right to expect in an instrument designed to avoid the personal equation and other sources of error which are inseparable from the present transit circle. In the use of our star camera, a description of which has been already published (No. 81 of the records of Sydney Observatory), I have been surprised at the stability, ease in manipulation, and accuracy that it is possible to attain, and the conviction has grown upon me that an instrument of the same general design, and made with all needful care, would be capable of recording on photographic plates the RA and NPD of stars with much greater accuracy than it is possible to secure with the existing transit circle. I therefore propose to put before you a design for an instrument intended to secure this much desired possibility of increased accuracy in determining the fundamental positions of stars.

I am aware that such a proposition may seem absurd to one not familiar with photographic methods and instruments, but the result proposed to be obtained is well worth discussing, and I will therefore submit the design for discussion, first giving a working drawing and description of the instrument itself. I shall then point out the method of working it, and the qualities which seem to me to promise greater accuracy than can now be obtained with the transit circle.

THE INSTRUMENT.

The accompanying print is a working drawing made to scale, and shows at once that the instrument is virtually a photographic equatorial, with the telescope mounted in the polar axis. The telescope and camera are combined in one rectangular tube BB, Nos. 1 and 15, carried by an axis CC in Nos. 15 and 11; this is carried by the divided polar axis AA, made of H-shaped steel girder, the section of which is shown at AA, No. 11. AA rests at its lower end on a hemispherical steel bearing A', and at its upper end on a cylindrical axis T in segmental bearings V, No. 7, from which part of the weight is taken by the friction-wheel collar UU, Fig. 8, and the weighted bent lever U, No. 15; the down thrust at the lower end A' being in part taken by friction rollers, lever and weight UUU resting against a sleeve end to the wheel NN. So far we have a very simple equatorial mounting of great stability, and very easily moved, and weighing about two tons; to this is added the graduated RA wheel NN, and the tangent screw wheel N'N'; this screw wheel works freely on a cylindrical bearing, and adds very little to the friction and freedom of movement in the polar axis, at the same time it can be instantly clamped to the wheel NN at the point K by half a turn of the handle J at the eye-end of the telescope through two pairs of bevel wheels at JJ. (See also J, No. 11.) The detail of the point K will be seen in Nos. 9 and 10, in which LK is a 12 to 1 lever pivoted on the wheel NN—*i.e.*, the RA wheel at K'. In No. 9 part of the clamping-rod J is shown; by means of this the piece K is clamped into a T-shaped groove in N', and this sliding piece K is linked to the upper end of the lever LK' at K''. The lower end of the lever LK' is shaped as an arc of a circle, and on it is a rack worked by a pinion and series of wheels at M, and controlled by an endless cord not shown. The grooved wheel and other details of this are shown in Diagram No. 3. This arrangement was designed to work instead of the usual tangent screw for slow motion, and it performs its functions very much better than a tangent screw, being quicker and more accurate than a screw. The clamp in declination can also be controlled at the eye-end of the telescope by the handle H through a pair of bevel wheels at H. (See also Diagram No. 11.) The declination clamp surrounds the declination axis at G No. 11, and the rod H No. 11 projects into the collar G slightly, but it is shaped there as in Diagram No. 12, which makes it act as an eccentric, and when it is turned by the handle H it clamps the declination collar that works in G No. 11—that is, when the upper or cut-away part, as in Diagram No. 12, is outward, the collar is not clamped, but when it is turned half round the lower or full part is brought outwards and projects, thus clamping the declination axis to the collar. Slow motion in declination is given by wheels and pinion at the end of the clamping collar similar to that shown in No. 3, in which one pinion of ten leaves is fixed on the axis of the grooved pulley, and this works into the wheel G of 100 teeth, which has a pinion working into the curved rack on the end of the lever C. Diagram No. 14 shows the clockwork, which is electrically controlled every second; this is in all respects similar to the clock and control of the star camera, and for details the reader is referred to the description of that instrument in No. 81 of our records. It may suffice here to say that the motion is controlled by a standard astronomical clock which makes it absolutely correct every second, and limits the possible error during any second to $\frac{1}{300}$ part of a second of time.

On the axis of the telescope Nos. 15 and 11 are two declination circles EE, each read by two microscopes FF, FF. Each pair of these are placed so that the observer may turn from one to the other without changing his place; the micrometers to be divided to seconds of arc and easily read to 0·1″.

For reading the right ascension circle the microscope O is provided, and is to be of the same power as those on the declination circle, so that the observer would easily see $\frac{1}{100}$ of a second of time on the RA circle; S in Nos. 2·13 and 15 show the shape and massive character of the lower bearing of the polar axis WW in No. 8; and XX show the iron part of the support of the upper end of the main axis—it is divided to admit of collimation observations.

In No. 4, D shows the segmental bearings of the telescope axis, the piece Y takes out to let the telescope axis in, and support is given by all three segmental bearings. The shape of Y is shown in No. 5, the projecting part of which takes the end thrust of the telescope axis when the polar axis is turned round. T No. 6 shows how the upper and lower bearings of the polar axis TT are attached to the girder. Z is a wooden table to carry chronograph and writing material for the observer at microscope O.

The graduation of the declination circles would require to be of the ordinary first-class quality; that of the RA circle would have to be unusually fine for 15 minutes before and after the meridian in both positions of the polar axis, because the right ascension of the object would be determined by the observer taking transits of these divisions under his microscope and recording them on the chronograph.

We proceed now to adjust this instrument and take an observation. Collimators, of course, would be required as in an ordinary transit circle. We turn the telescope until the RA circle reads the meridian, and proceed to collimate as in an ordinary transit instrument. Having finished this we turn the polar axis 180 degrees, and collimate as before. The telescope is now turned vertical, and the nadir and level reading found by reflection from mercury. The single RA wire in the telescope having been set to the collimation reading, the telescope is moved by means of the fine motion in RA until the wire covers its own reflection. A set of level readings is taken to see if the setting vertical has been exact; if not, the error goes as a correction to the reading for the meridian at microscope O. The polar axis is again turned 180 degrees, and the determination of nadir and level is made as before. We have thus determined the collimation, nadir, and level of the instrument in both positions, as well as the flexure in the telescope tube and in the main axis. We test the elevation of the polar axes by observing stars in the meridian.

We next observe stars above and below the pole in both positions of the polar axis, to determine the azimuth; if it comes the same in both positions we know that the telescope axis is at right angles to the polar axis, and that if not it must be adjusted, and the polar axis must be also adjusted for any error of azimuth by moving the upper segmental bearing until it is adjusted. This motion, as well as that for vertical adjustment of the polar axes, is provided for in the cup-bearing at the other end.

Having now adjusted the instrument as an ordinary transit, and in its polar axis, it will be necessary to see that the star camera line of collimation is parallel to that of the telescope.

ADJUSTMENT OF CAMERA.

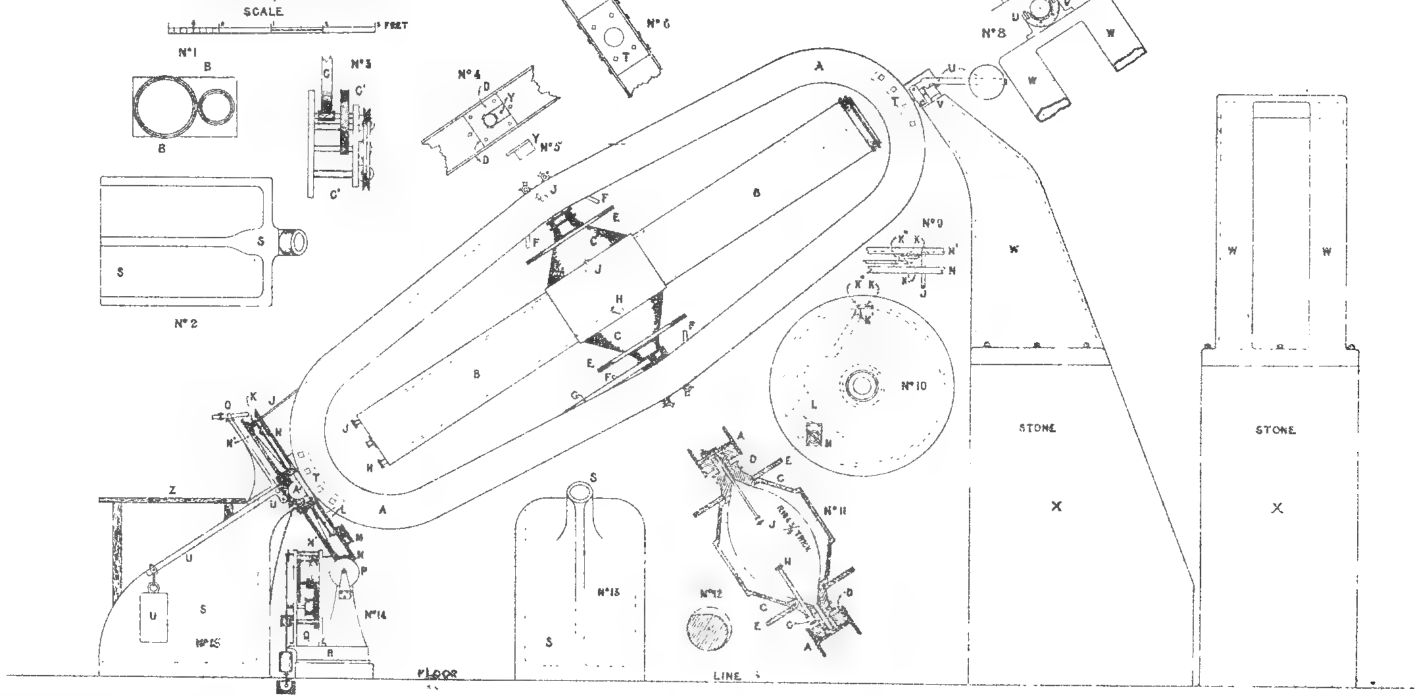
The provision for holding the photographic plate is similar to that used in the star camera, which holds the plate firmly against carefully made stops, so that it cannot move from the position in which it is held. Means of adjustment of this plate-holder would be provided, and also the means for fixing it rigidly when it is adjusted.

We now proceed to test the collimation of the camera, and we assume that the photographic lens has been set as truly as possible at right angles to its tube, and therefore, since it turns on the same axes as the telescope which has been adjusted in collimation, it will in the two positions of the instrument record the star on exactly the same point of the plate, except there be any unknown errors of collimation or flexure due to the position of the telescope in declination, and differing from those found to exist in the horizontal and vertical positions in which it was tested. During the time the plate was exposed to the star the observer has constantly observed the star on the wire, and if the bisection has not been perfect he has instantly corrected it. So that the mean position is one of accurate bisection of the star, and experience shows that this is possible, because perfectly round photographic star images are easily obtained, and it is obvious that such a bisection of the star is immeasurably better than that of the flying shot method unavoidable in the ordinary transit circle.

If the two images are not superposed then the centre of the spot made by the two images may be safely assumed to be the mean of the unknown errors, and if it does not wholly eliminate them it must at least be a more accurate position for the star than that obtained in an ordinary transit circle, which does not permit of the determination of these errors by any direct method, except in so far as the reversible transit circle of moderate dimensions provides for it. But the star camera form of reverser works much more smoothly than the other form, and has the great advantage of reversing not only the telescope but also the stand itself, and at the same time avoids jars to the instrument, and provides for a far more accurate bisection of the star as we have seen.

In taking observations or rather photographs by this instrument two observers are necessary, and the work would be better and much more rapidly done by three—one to observe the star bisected by the wires, another to read the microscopes on each declination circle in each position of the polar axis, and the third to read and record on a chronograph the time of transit. It has already been mentioned that the graduations for 15 minutes of time on each side of the zero, *i.e.*, the point indicating that the telescope was in the plane of the meridian, and the determination of that point by observation of a mercury reflector, have also been stated. It remains now to mention that RA graduations or marks should be at 10 seconds intervals; this is quite possible since the RA wheel is 3 feet in diameter. Hence seven of these marks would pass under the microscope each minute; the microscope is powerful enough to enable the observer to see easily $\frac{1}{100}$ of a second of time, and the parallel wires in the microscope should be exactly suited to the division lines. A point on the graduations would be chosen so that the observation begun there would be soon enough to admit of reversal and picking up the corresponding divisions on the other side of the meridian. Since there would only be a few of these division lines in use, it would be possible to determine with great accuracy their relation to the meridian line.

PHOTOGRAPHIC TRANSIT CIRCLE



In making the observation the telescope would be set on the desired star before the meridian; the RA observer would give the signal when the plate should be uncovered and then record on the chronograph the time that each division of the circle passed the microscope. When done he would give the signal for covering the plate and its reversal, and then repeat the observation in that position as before. Now, since the graduated circle would move steadily on without the slightest vibration even under the high power microscope, he would be able to determine the RA with much greater accuracy than is possible in the ordinary transit circle, and that motion being always at the same rate, even for stars close to the pole, the observer would be able to record the RA with extreme accuracy for stars in all declinations.

I have, I think, said sufficient to place before you a fair outline of the instrument and the method of using it; to make this complete in every detail would require a small volume, and is not necessary. If I have demonstrated the principles involved, and I think I have done so, my present purpose will be served, and if my estimate of the quality of the work which would be done with this instrument is correct, the design for it will be all the better for discussion.

I would only add that the photographic field might be two degrees, and that there would be two images of any stars, save the guide star, that might be in the photographic field, and their positions relative to the guide star would be determined with the needful accuracy by measurement. With the 13·1 inches objectives used for the star chart we can easily get a hard round image of an eleventh magnitude star in one minute with increased experience in manufacture; and with Jena glass it is fair to assume that star images would be smaller and better defined, and measurement more accurate than it is now, and even now they can be made good enough to justify the making of the photographic transit circle here described.

4.—ON A FORM OF THE DIFFERENTIAL EQUATIONS OF DYNAMICS.

By Sir ROBERT BALL, LL.D., F.R.S., Lowndean Professor of Astronomy and Geometry at Cambridge.

I refer to a series of memoirs in the Royal Irish Academy's Transactions for the explanation of the terms and notation employed in this paper.

Euler's well-known equations for the rotation of a rigid body about a fixed point are but a particular case of a much more general theorem, which applies to any dynamical system whatever.

I shall take, as the screw-chains of reference, the n principal screw-chains of inertia, the material system being of any type whatever and having n degrees of freedom.

Let $f_1, \ldots f_n$ be the components of the acting forces expressed as wrench-chains on the n wrench-chains of reference.

Let $p_1, \ldots p_n$ be the pitches of the chains of reference.

If then T be the kinetic energy of the system, we have from Lagrange's Equations the following:—

$$\frac{d}{dt}\left(\frac{dT}{d\dot{x}_1}\right) - \frac{dT}{dx_1} = 2p_1 f_1$$

&c., &c.

$$\frac{d}{dt}\left(\frac{dT}{d\dot{x}_n}\right) - \frac{dT}{dx_n} = 2p_n f_n.$$

It can, however, be shown that T submits to an identical equation from the vanishing of the following emanant:—

$$\dot{x}_1 \frac{dT}{d\dot{x}_1} + \cdots \dot{x}_n \frac{dT}{d\dot{x}_n} = 0.$$

Differentiating this with regard to $\dot{x}_1$, we have—

$$\frac{dT}{d\dot{x}_1} + \dot{x}_1 \frac{d^2T}{d\dot{x}_1\,d\dot{x}_1} + \dot{x}_2 \frac{d^2T}{d\dot{x}_2\,d\dot{x}_1} + \cdots + \dot{x}_n \frac{d^2T}{d\dot{x}_n\,d\dot{x}_1} = 0,$$

but
$$\frac{d}{dt}\left(\frac{dT}{d\dot{x}_1}\right) = \frac{d^2T}{d\dot{x}_1^2}\cdot\ddot{x}_1 + \frac{d^2T}{d\dot{x}_1\,d\dot{x}_2}\ddot{x}_2 + \cdots + \frac{d^2T}{d\dot{x}_1\,d\dot{x}_n}\ddot{x}_n$$
$$+ \dot{x}_1 \frac{d^2T}{d\dot{x}_1\,dx_1} + \dot{x}_2 \frac{d^2T}{d\dot{x}_2\,dx_2} + \cdots$$

whence Lagrange's Equations become in this case—

$$\ddot{x}_1 \frac{d^2T}{d\dot{x}_1^2} + \ddot{x}_2 \frac{d^2T}{d\dot{x}_1\,d\dot{x}_2} + \cdots + \ddot{x}_n \frac{d^2T}{d\dot{x}_1\,d\dot{x}_n} = 2p_1\left(f_1 + \frac{1}{p_1}\frac{dT}{dx_1}\right)$$

$$\vdots$$

$$\ddot{x}_1 \frac{d^2T}{d\dot{x}_1\,d\dot{x}_n} + \ddot{x}_2 \frac{d^2T}{d\dot{x}_1\,d\dot{x}_2} + \cdots + \ddot{x}_n \frac{d^2T}{d\dot{x}_1\,d\dot{x}_n} = 2p_n\left(f_n + \frac{1}{p_n}\frac{dT}{dx_n}\right)$$

as, however, T can at any instant be expressed in this form—

$$T = M\left(n_1^2 \dot{x}_1^2 + \cdots + n_n^2 \dot{x}_n^2\right)$$

when the quantities—

$$M,\ n_1^2,\ \ldots\ n_n^2$$

depend upon the masses and the disposition of the material system we have—

$$\frac{d^2T}{d\dot{x}_1^2} = 2Mn_1^2, \quad \&c., \quad \frac{d^2T}{d\dot{x}_n^2} = 2Mn_n^2,$$

and
$$\frac{d^2T}{d\dot{x}_1\,d\dot{x}_2} = 0, \quad \&c., \quad \frac{d^2T}{d\dot{x}_1\,d\dot{x}_n} = 0,$$

whence the equations of motion in this case assume the very simple form—

$$Mn_1^2\ddot{x}_1 = p_1\left(f_1 + \frac{1}{p_1}\frac{dT}{dx_1}\right)$$

&c.,

$$Mn_n^2\ddot{x}_n = p_n\left(f_n + \frac{1}{p_n}\cdot\frac{dT}{dx_n}\right).$$

It seems hardly possible to have the equations of motion in a more concise form than these, inasmuch as they give explicitly the accelerations of the co-ordinates.

If there be no external forces, then $f_1, \cdots f_n$ are all zero, and the equations become—

$$Mn_1^2\ddot{x}_1 = \frac{dT}{dx_1}$$

$$\cdots$$

$$Mn_n^2\ddot{x}_n = \frac{dT}{dx_n}.$$

We note that the equations—

$$\frac{dT}{dx_1} = 0, \cdots \qquad \frac{dT}{dx_n} = 0$$

express the conditions that the movement shall be such that there is no immediate tendency to vary it.

5.—AN ELEMENTARY EXPOSITION OF THE THEORY OF POWER SERIES.

By G. FLEURI, Licencié ès-sciences mathématiques, Licencié ès-sciences physiques.

The representation of functions of one variable by means of series (Power Series) plays a very important part in mathematical science. However, with the exception of Chrystal's Algebra—a highly valuable book (see especially Part II., Edinburgh, 1889)—there is not a single English treatise dealing with the subject in a vigorous manner. Moreover, Mr. Chrystal's work is incomplete, mainly owing to the fact that he does not make use of the notions of Differential and Integral.

I have attempted, in the following, to give an exposition—as elementary as possible—of the important theory in question; but, in order to preserve uniformity and simplicity in the demonstrations, I have had to restrain the generality of the main theorem—that of Abel.

Throughout this paper I use the word "series" as meaning a succession of an infinite number of quantities following a definite law of formation and connected by the signs *plus* or *minus*.

The quantities with their signs are called the *terms* of the series.

The terms of the series may be positive, negative, or more generally complex quantities.*

In all cases of use of series, the first matter to be ascertained is whether the infinite succession of terms represents a definite quantity or not.

Considering first a series—

$$u = u_1 + u_2 + \dots + u_n + \dots$$

having for its terms positive quantities only—viz., in fact, *numbers*—the number—

$$\Sigma u_n = u_1 + u_2 + \dots + u_n \cdot$$

increases with n; and two cases are to be considered. Either Σu_n has a limit, in which case the series represents precisely this limit; or it has no limit, and in that case the series represents nothing definite.

As is well known, the series in the first case is said to be *convergent*, in the second case *divergent*.

And these definitions are naturally extended to any kind of series, that is to say: A series is said to be *convergent* when the sum of its n first terms has a limit for $n = \infty$, *divergent* in the contrary case.†

Convergent series having positive and negative terms—

$$v = v_1 + v_2 + \dots + v_n + \dots$$

which we come now to consider, are to be divided into two great classes, according as the series formed with the terms taken in absolute value is convergent or divergent.

Denoting by V_r the absolute value of v_r—that is to say, the value of the term v_r independently of its sign (modulus, tensor)—if

$$S = V_1 + V_2 + \dots + V_n + \dots$$

is convergent, it can be proved as follows that v is convergent‡:—

Denote by P_n the sum of all the positive terms to be found amongst the n first terms of the series v and by Q_n the sum of the negative terms, taken in absolute value, of the same n first terms of the series.

$$\Sigma_n = v_1 + v_2 + \dots + v_n = P_n - Q_n$$

and also $$S_n = V_1 + V_2 + \dots + V_n = P_n + Q_n$$

As S_n has by hypothesis a finite limit, neither P_n nor Q_n can be infinite at the limit ($n = \infty$); or in other terms P_n and Q_n must have separately a limit for $n = \infty$.

Let—

$$\lim. P_n = P$$
$$\lim. Q_n = Q$$

then—

$$\lim_{n-\infty}. \Sigma_n = P - Q$$

Q.E.D.

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* In the present paper I will not consider the latter series.

† According to these definitions, what is called here convergent series includes the convergent and semi-convergent series of certain authors, and what is called divergent series includes the divergent and oscillating series.

‡ Although this demonstration is well known, I have thought it necessary to give it again, in order to emphasise certain points which are not perhaps sufficiently insisted upon in ordinary treatises.

But it is easily seen that the converse proposition is not true—that is to say, it is not sufficient that v have a limit in order that S may be convergent, as the well-known example—

$$\log. 2 = 1 - \tfrac{1}{2} + \tfrac{1}{3} - \tfrac{1}{4} + \ldots . + \frac{1}{2n-1} - \frac{1}{2n} + \ldots .$$

sufficiently proves.

In the first case—viz., when S is convergent—the series v is said to be *absolutely convergent.*

Any convergent series whose terms are all positive integers is absolutely convergent.

According to Riemann (Ueber die Darstellbarkeit einer Function durch eine trigonometrische Reihe, § 3) Dirichlet was the first to clearly perceive the great difference which exists between series absolutely convergent and series convergent only; but to Riemann himself (*loc. cit.*, § 3) belongs the honour of having put that difference in a very forcible light.

In the former series (absolutely convergent) the order of the terms may be altered in any manner whatever without changing the value of that series, but the case is quite different with regard to series convergent only; for—as Riemann has pointed out—*we may make any series convergent only, take any value we please, by arranging the terms in an appropriate order.*

This statement is based upon the simple fact that (using the notations above)—

$$\lim. P_n = \infty$$

and also $\lim. Q_n = \infty$ for $n = \infty$

Then let—

$$a_1 \quad a_2 \quad a_3 \ldots . a_p \ldots . .$$

and

$$b_1 \quad b_2 \quad b_3 \ldots \ldots b_q \ldots$$

be respectively the positive and the negative terms of any of those series arranged in decreasing order, and let C be any quantity whatever (supposed positive to fix the ideas). Take *just* enough positive terms to bring their sum above C, then add *just* enough negative terms to bring the sum below C; again add *just* enough positive terms to bring the sum above C, etc. We can repeat this operation indefinitely, since—

$$\lim. P_n = \infty$$
$$\lim. Q_n = \infty$$

and therefore form a series. But the difference (in absolute value) between one of the above expressions and C never exceeds the term (in absolute value) preceding the last change of sign, and, as owing to the convergence of the series under consideration,

$$\lim_{p=\infty} a_p = 0 \qquad \lim_{q=\infty} b_q = 0$$

that difference must be infinitely small—that is to say, C *will be the limit of the series we have formed.* A very simple example will make this clear. Take

$$\log. 2 = 1 - \tfrac{1}{2} + \tfrac{1}{3} - \tfrac{1}{4} + \ldots\ldots + \frac{1}{2n-1} - \frac{1}{2n} + \ldots\ldots$$

$$= \sum_{n=1}^{n=\infty}\left(\frac{1}{4n-3} - \frac{1}{4n-2} + \frac{1}{4n-1} - \frac{1}{4n}\right)$$

and also

$$X = 1 + \tfrac{1}{3} - \tfrac{1}{2} + \tfrac{1}{5} + \tfrac{1}{7} - \tfrac{1}{4} + \ldots + \frac{1}{4n-3} + \frac{1}{4n-1} - \frac{1}{2n} + \ldots$$

$$= \sum_{n=1}^{n=\infty}\left(\frac{1}{4n-3} + \frac{1}{4n-1} - \frac{1}{2n}\right)$$

log. 2 and X are series differing only in the order of their terms.

Make the difference—

$$X - \log. 2 = \tfrac{1}{2}\sum_{n=1}^{n=\infty}\left(\frac{1}{2n-1} - \frac{1}{2n}\right)$$

or $$X - \log. 2 = \tfrac{1}{2}\log. 2$$ so that

$$X = \tfrac{3}{2}\log. 2.$$

Having now emphasised the importance of the separation of series into absolutely convergent and convergent, we come to the main part of this paper.

FUNCTIONS REPRESENTED BY MEANS OF SERIES.

And first of all: Under what conditions may a series represent a continuous function?

Cauchy, in his "Cours d'Analyse Algébrique ou de l'Ecole Polytechnique," had enunciated the following proposition:—

"When the different terms of the series

$$u_1 + u_2 + \ldots\ldots + u_n + u_{n+1} + \ldots\ldots$$

are functions of a single variable x, continuous with regard to this variable, in the neighbourhood of a certain value for which the series is convergent, the sum of the series is also, in the neighbourhood of that value, a continuous function of x."

Abel, in a footnote of his well-known "Mémoire sur la série—

$$1 + \frac{m}{1}x + \frac{m(m-1)}{1\cdot 2}x^2 + \ldots\ldots"$$

[written in French by Abel during the winter 1825-26, translated into German by Crelle and published in his journal in the month of February or March, 1827—See "Œuvres Complétes d'Abel," edit.

1881, p. 220] points out that Cauchy's theorem is obviously subject to some exceptions, as the series—

$$\sin. x - \tfrac{1}{2}\sin. 2x + \tfrac{1}{3}\sin. 3x - \ldots.$$

representing $\frac{x}{2}$ for $-\pi < x < \pi$, is no longer equal to that function when x tends towards π, since the limit of the series is zero, whilst

$$\lim_{x=\pi} . \frac{x}{2} = \frac{\pi}{2}.$$

(See also a letter from Abel to Holmboe, 16th January, 1826; Œuvres complétes, p. 256.)

Cauchy, who was so much engrossed with his original work that he had seldom time to read any outside publication, did not answer Abel's objections till 1853. But in the "Comptes rendus de l'Académie des Sciences, 14 Mars, 1853," in a "Note sur les séries convergentes dont les divers termes sont des fonctions continues d'une variable réelle ou imaginaire, entre des limites données." He corrects very fully his error, and replaces his theorem by the following:—

"If the several terms of the series—

$$(1) \qquad u_1 + u_2 + \ldots. + u_n + u_{n+1} + \ldots.$$

are functions of the real variable x, continuous with regard to that variable between certain given limits, and if also the sum

$$r_{n'} = u_{n+1} + \ldots + u_{n'}$$

becomes always infinitely small for very great values of the positive integer n, and infinitely great values of $n' > n$, the series (1) will be convergent, and between the given limits a continuous function of the variable x.

The demonstration of the theorem is immediate, and is based upon the fact that the series is equal to the sum of its n first terms S_n (n being as great as we please, but finite), and the limit of the rest $r_{n'}$ for $n' = \infty$. By reason of the conditions given, S_n is obviously a continuous function of x, whilst nothing can be said *a priori* about $r_{n'}$.

But, prior to Cauchy, the question had been thoroughly sifted by the German mathematician, Seidel. [*Note.*—"Über eine Eigenschaft von Reihen welche discontinuirliche Functionen darstellen"—Abhandlungen der Bayerischen Akademie, 1847-49.] Not only does Seidel give the result afterwards rediscovered by Cauchy, but he goes more deeply into the nature of the series considered, and demonstrates the following proposition:—

"If the terms of a convergent series are continuous functions of the variable x, but the series itself represents a discontinuous function of x, there will exist in the immediate neighbourhood of the point where a break occurs in the value of the function (*i.e.*, where the function is discontinuous) some values of x which will make the series converge as slowly as we please."

For readers desirous of an acquaintance with this idea of infinitely slow convergency we refer to Seidel's paper, or to Chrystal's Algebra (Part II., p. 130).

The series

$$\sum_{n=1}^{n=\infty} \frac{x}{(nx+1)\,[(n-1)\,x+1]} = \sum_{n=1}^{n=\infty} \left[\frac{nx}{nx+1} - \frac{(n-1)\,x}{(n-1)\,x+1}\right]$$

has been given by P. du Bois-Reymond (Antrittsprogr., p. 25) as an instance of infinitely slow convergency for $x = 0$. The sum of the first n terms—

$$S_n = \frac{nx}{nx+1}$$

$$\lim_{n=\infty} S_n = 1 \qquad \lim.\ r_{n'} = 1 - S_n = 1 - \frac{nx}{nx+1} = \frac{1}{nx+1}$$

and we see at once that the smaller x the greater n must be taken to have lim. $r_{n'}$ infinitely small.

The series—

$$\sum_{n=1}^{n=} \frac{x^2}{(1+x^2)^n}$$

presents also the same peculiarity for $x = 0$.

In modern language a series

$$f(x) = u_1(x) + u_2(x) + \ldots . + u_n(x) + \ldots .$$

convergent for

$$a < x < b$$

is said to be *uniformly convergent* in the neighbourhood of $x = x_0$, $a < x_0 < b$, when we can take n sufficiently great to have in absolute value—

$$R_n(x) = u_{n+1}(x) + u_{n+2}(x) + \ldots .$$

infinitely small, whatever be the value of x between $x_0 + \epsilon$ and $x_0 - \epsilon$, ϵ being infinitely small.

The series is said to be *uniformly convergent* between α and β, $a < \alpha < \beta < b$, when it is uniformly convergent in the neighbourhood of any value of x between α and β.

The notion of uniform convergency had been clearly introduced—as we have seen—in the memoir of Seidel and the note of Cauchy, and seemed therefore acquired to science. However, strange to say, it had remained unnoticed for years by the majority of mathematicians, when Weierstrass, without probably any knowledge of Seidel's paper or Cauchy's note, reintroduced it in his lectures at Berlin. No printed communication exists from the pen of Weierstrass,* but one of his

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* *See* P. du Bois Reymond—Beweis dass die Coefficienten der trigonometrischen Reihe, etc. Footnote, p. 119—Abhandlungen der Bayerischen Akademie, Band XII.

pupils, Heine, in a memoir, "Ueber trigonometrische Reihen" [February, 1870—published in Crelle's journal, Band 71, p. 353], says :—

"Until recently it was believed that the integral of a convergent series, whose terms were finite between the finite limits of integration, was equal to the sum of the integrals of each term, and Herr Weierstrass was the first to point out that, in order to demonstrate this theorem, it is required not only that the series converges between the limits of integration but still converges uniformly (in gleichem Grade convergire)."

At the same time, however, Heine remarks that, in a paper previously published in the volume 66 (1866 A.D.) of the same journal (Crelle's journal), Thomé* had regarded the notion of uniform convergency as already acquired. It was seen later on that the priority belonged to Seidel's work. In relation to his theorem it must not be thought that infinitely slow convergency always involves discontinuity. P. du Bois-Reymond, in "Beweis dass die Coefficienten," etc.—Abhandlungen der Bayerische Akademie, Band XII. (footnote, p. 119)—has shown by an example that a series may represent a continuous function of x during an interval when the convergency is infinitely slow; a fact shown by Seidel (*loc. cit.*, p. 393). This example is also reproduced in Chrystal's Algebra (Part II., p. 131). To complete the history of these investigations we will add that Duhamel had also, after Cauchy, considered the same question (Comptes rendus, etc., 1853, p. 643).

It results from the above considerations that it is not admissible to consider a convergent series as representing a continuous function of x—even when its terms are continuous functions of x—without careful examination.

The following theorem embodies all our knowledge on the subject of the representation of continuous functions by series :—

THEOREM I.

Any function $f(x)$ represented by the series—

$$f(x) = u_1(x) + u_2(x) + \ldots + u_n(x) + \ldots$$

(convergent for $a < x < b$) where the terms are continuous functions of x will be itself a continuous function of x in the neighbourhood of any value x_0 of x (between a and b) if the series is uniformly convergent in the neighbourhood of that value x_0.

ϵ being an infinitely small quantity, we have—

$$f(x_0 + \epsilon) - f(x_0) = u_1(x_0 + \epsilon) + \ldots + u_n(x_0 + \epsilon) - [u_1(x_0) + \ldots + u_n(x_0)] + R_n(x_0 + \epsilon) - R_n(x_0).$$

As each term of the series is a continuous function of x in the neighbourhood of x_0—

$$u_1(x_0 + \epsilon) + \ldots + u_n(x_0 + \epsilon) - [u_1(x_0) + \ldots + u_n(x_0)]$$

is infinitely small (n being finite); and if $f(x_0)$ is assumed to be uniformly convergent in the neighbourhood of x_0, $R_n(x_0 + \epsilon)$ and $R_n(x_0)$ may be taken—(each separately)—infinitely small, wherefore $f(x_0)$ will be then continuous in the neighbourhood of $x = x_0$.

* "Ueber hypergeometrische Kettenbrüche," p. 334.

THEOREM II.

The series formed by the integrals of the terms of $f(x)$ will represent the integral of $f(x)$ during any interval where $f(x)$ is uniformly convergent; the limits of integration being included between those of uniform convergency.

We may write—

$$f(x) = u_1(x) + u_2(x) + \ldots + u_n(x) + R_n(x),$$

therefore, as the number of terms is limited—

$$\int_a^\beta f(x)\,dx = \int_a^\beta u_1(x)\,dx + \int_a^\beta u_2(x)\,dx + \ldots + \int_a^\beta u_n(x)\,dx + \int_a^\beta R_n(x)\,dx$$

where α and β are included between the limits a and b of uniform convergency—

$$a < \alpha < \beta < b.$$

Now, from the theorem of mean values—

$$\int_a^\beta R_n(x)\,dx = (\beta - \alpha)\,R_n(\xi)$$

where ξ is a value of x between α and β — and as $R_n(\xi)$ may be taken infinitely small from the hypothesis—

$\int_a^\beta R_n(x)\,dx$ may be also taken infinitely small;

that is to say, the series—

$$\int_a^\beta u_1(x)\,dx + \int_a^\beta u_2(x)\,dx + \ldots\ldots$$

is convergent,* and represents—

$$\int_a^\beta f(x)\,dx$$

We come now to the special case of series arranged in order of increasing powers (whole and positive) of the variable x, such as series obtained by means of the so-called Maclaurin's formula.

Let—

$$u = a_0 + a_1 x + a_2 x^2 + \ldots + a_n x^n + \ldots\ldots$$

be such a series.

* The necessary and sufficient condition for the convergence of a series is that the sum of any number of its terms after the nth be infinitely small.

THEOREM III.

If u be *convergent* for $x = x_0$, it will be *absolutely convergent* for all values of x smaller in absolute value than x_0. (See Abel *loc. cit.*, th. II., Œuvres, p. 222.)

Let A represent the absolute value of a

and X ,, ,, ,, x.

If the series is convergent for $x = x_0$ its terms must be ultimately smaller than any given quantity α, however small—that is to say, we must have $A_n X_0^n < \alpha$, whatever be n; therefore the series—

$$(1) \qquad A_0 + A_1 X + \ldots + A_n X^n + \ldots$$

where—

$$X < X_0$$

is convergent as having its terms respectively smaller than those of the obviously convergent series—

$$\alpha + \alpha \frac{X}{X_0} + \alpha \left(\frac{X}{X_0}\right)^2 + \ldots + \alpha \left(\frac{X}{X_0}\right)^n + \ldots$$

But the convergence of (1) means, by definition, the absolute convergence of u, so that our proposition is established.

THEOREM IV.

If u be *absolutely convergent* for $x = x_0$, it will be *uniformly convergent* for—

$$-x_0 < x < x_0$$

limits included.

From a well-known theorem on convergence of series whose terms are positive integers,* to say that u is absolutely convergent for $x = x_0$ means that we can take n sufficiently great to have

$$R_n(X_0) = A_{n+1} X_0^{n+1} + A_{n+2} X_0^{n+2} + \ldots + A_{n+p} X_0^{n+p}$$

smaller than ϵ, ϵ being a given quantity as small as we please, whatever be the value of p.

But taking $X \leqq X_0$ we have—

$$A_{n+1} X_0^{n+1} \left(\frac{X}{X_0}\right)^{n+1} \leqq A_{n+1} X_0^{n+1}$$

$$A_{n+2} X_0^{n+2} \left(\frac{X}{X_0}\right)^{n+2} \leqq A_{n+2} X_0^{n+2}$$

$$\cdots\cdots\cdots\cdots$$

$$A_{n+p} X_0^{n+p} \left(\frac{X}{X_0}\right)^{n+p} \leqq A_{n+p} X_0^{n+p}$$

* See foot-note, p. 218.

since $\frac{X}{X_0} \leqq 1$; wherefore by addition—

$$A_{n+1} X_0^{n+1} \left(\frac{X}{X_0}\right)^{n+1} + A_{n+2} X_0^{n+2} \left(\frac{X}{X_0}\right)^{n+2} + \ldots$$

$$+ A_{n+p} X_0^{n+p} \left(\frac{X}{X_0}\right)^{n+p} \leqq A_{n+1} X_0^{n+1} + A_{n+2} X_0^{n+2}$$

$$+ \ldots + A_{n+p} X_0^{n+p}$$

or $R_n(X) \leqq R_n(X_0)$ whatever be the value of p;

therefore $a_0 + a_1 x + a_2 x^2 + \ldots + a_n x^n + \ldots$

where $X \leqq X_0$ *i.e.*, $x < x_0$ in absolute value,

or $-x_0 < x < x_0$

(the signs of inequality including the sign of equality) is uniformly convergent.

In the case where the series is convergent (only) for $x = x_0$, we have seen (th. III.) that it is absolutely convergent, for

$$-\xi < x < \xi$$

where ξ is a quantity as near x_0 as we please, but never equal to it; so that (according to th. IV.) our series converges uniformly, for $-\xi < x < \xi$.

This theorem is due to Abel (*loc. cit.*, th. IV. and V., Œuvres p. 223), who has shown that the series is uniformly convergent *even for* $x = x_0$. But his demonstration necessitates the establishment of a preliminary lemma (Œuvres, *loc. cit.*, th. III., p. 222). The preceding demonstration is less complete, but easier to follow.

THEOREM V.

The series—

$$\phi(x) = a_1 + 2a_2 x + \ldots + u\, a_n x^n + \ldots$$

whose terms are respectively the derivatives of the terms of the series u, represents the derivative of this series u in any interval whenever u is absolutely convergent.

For u is absolutely convergent for

$$\frac{A_{n+1} X^{n+1}}{A_n X^n} < 1 \quad \text{at the limit, or}$$

$$X < \text{Lim.} \frac{A^n}{A_{n+1}}$$

Let Lim. $\frac{A_n}{A_{n+1}} = a$; then we have

$$-a < x < a$$

for the condition of absolute convergency of u.

With regard to $\phi(x)$, the condition of absolute convergency is—

$$X < \lim. \quad \frac{n}{n+1} \cdot \frac{A_n}{A_{n+1}}$$

or
$$X < a, \text{ since } \lim. \frac{n}{n+1} = 1$$

i.e.,
$$-a < x < a \qquad \text{as before.}$$

During the interval of absolute convergency we can write (from th. II.)—

$$\int_0^x \phi(x)\, dx = a_1 x + a_2 x^2 + \ldots + a_n x^n + \ldots$$

equality, whose meaning is that $\phi(x)$, is the derivative of—

$$u = a_0 + a_1 x + a_2 x^2 + \ldots + a_n x^n + \ldots$$

therefore—

$$\phi(x) = \frac{du}{dx}.$$

This proposition is very important, for, as Weierstrass has pointed out in the remark given by Heine, it may occur that, although a series is convergent, the series formed by the derivatives may be divergent, and therefore represent nothing. Such is the case for the convergent series—

$$\frac{\sin. x}{1} + \frac{\sin. (2^2 x)}{2^2} + \frac{\sin. (3^2 x)}{3^2} + \ldots . + \frac{\sin. (n^2 x)}{n^2} + \ldots .$$

The series, deduced by derivating its terms, is divergent.

In short, the series—

$$f(x) = a_0 + a_1 x + a_2 x^2 + \ldots . + a_n x^n + \ldots .$$

absolutely convergent between $-a$ and $+a$, defines during that interval a *continuous* function of x, capable of derivation and integration—

$$f^1(x) = a_1 + 2a_2 x + \ldots . + na_n x^{n-1} + \ldots .$$

$$\int_0^x f(x)\, dx = a_0 x + \frac{a_1 x^2}{2} + \frac{a_3 x^3}{3} + \ldots\ldots + \frac{a_n x^{n+1}}{n+1} + \ldots\ldots$$

and we have, for instance, from the continuity—

$$\lim. f(x) = f(\lim. x)$$

during the interval of absolute convergency.

As an example consider the series

$$f(x) = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \dots\dots\dots$$

absolutely convergent for $-1 < x < 1$; we shall have—

$$f^1(x) = 1 - x^2 + x^4 - x^6 + \dots\dots\dots$$
$$= \frac{1}{1 + x^2}$$

therefore $$f(x) = \int_0^x \frac{dx}{1 + x^2} = \text{arc tan. } x$$

$\left(\text{taking the arc between } -\frac{\pi}{2} \text{ and } +\frac{\pi}{2}\right)$ and the series $\Sigma(-1)^n \frac{x^n}{n}$ represent arc tan. x for $-1 < x < 1$.

With regard to $x = 1$ the series $\Sigma(-1)^n \frac{x^n}{n}$ is still convergent (only), but the notions we have given are no longer sufficient to study it; we must have recourse to Abel's theorem (complete). This theorem shows that the series still represents arc tan. x for $x = 1$, *i.e.*, $\frac{\pi}{4}$.

It would be easy to extend the preceding results to series whose terms are complex quantities.

Any series

$$a_0 + a_1x + a_2x^2 + \dots + a_nx^n + \dots\dots$$

absolutely convergent for all points inside a circle of radius a defines in that circle (*i.e.*, for all the points inside that circle) a continuous function of x capable of derivation and integration.

This is Briot and Bouquet's theorem. (Recherches sur les séries ordonnées suivant les puissances croissantes d'une variable imaginaire —C.R. 1853, p. 264 and p. 334).

6.—THE ENERGY OF THE ELECTRO-MAGNETIC FIELD.

By PROFESSOR BRAGG, M.A.

The expressions for the energy of an electro-magnetic field are deduced from certain principles laid down by Maxwell. In the deduction it is not at all necessary to employ, as is often done, the idea of the "magnetic shell." This idea is not only highly artificial but is apt to lead to wrong impressions. The shell cannot be made of a number of small and similar steel magnets placed side by side. It consists of two layers of magnetism, separated by a thin uniform layer of air. In fact it is, as I pointed out in an address to this Section at Hobart, the magnetic analogue of the electrostatic plate condenser.

In order to understand how the expressions can be obtained without using the magnetic shell, it is, I think, a help to use first an analogy.

Suppose the existence of an infinite incompressible medium, each particle of which requires to displace it from its natural position a force proportional to the displacement. The constant of this proportion may be different in different parts of the medium. If its value be E, and a unit volume be displaced a distance d, the force required is Ed, and the energy stored up in this portion of the medium is $\frac{1}{2} Ed^2$*

Suppose a membrane placed in this medium, the medium being uniform and of elasticity (everywhere) E. If a uniform pressure be brought to bear on the membrane, it will be displaced. Most of the displacement will take place at the edges, and the membrane will take a convex form to the pressure, the opposite to the form taken by a sail before the wind. The lines of displacement will run from front to back of the membrane, and will occur in greatest numbers, if number be made to represent amount of displacement, near the edge. In fact, in the case of a circular membrane, the disposition of the lines is given in Maxwell's Electricity and Magnetism, Plate XVIII. *Lines due to a circular current.*

If the pressure per unit area be P, the total displacement of the membrane, or volume moved through, will be proportional to P, say, lP, where l is a constant depending on the shape (really contour only) of the membrane and the elasticity of the surrounding medium. The energy stored up in the medium will be $\frac{1}{2} lP^2$.

Suppose, now, a second membrane placed in the medium, and the medium strained by a pressure P′ on this membrane. The work done in straining it will be exactly the same as if there were not already a strain in the medium due to the pressure on the first membrane, because every particle requires the same force to displace it—a given amount in a given direction, no matter whether it is already displaced or not. If, then, the total displacement of the second membrane is nP', the work done in submitting it to a pressure P′ is $\frac{1}{2} nP'^2$.

But whilst the second membrane is being displaced the first membrane is displaced also, and the amount of the displacement is mP', where m is a constant depending on the nature of the medium and the shapes and relative positions of the membranes. A pressure P is acting on the first membrane all the time it is undergoing the further displacement, so that an amount of energy $P.\ mP'$ is done on the medium thereby. Thus the whole energy stored up in the medium is $\frac{1}{2} lP^2 + mPP' + \frac{1}{2} nP'^2$. Plainly the order in which the displacements of the membranes are supposed to take place could be reversed without altering the ultimate amount of energy stored up in the medium, so that the constant m may mean either the total displacement of the first membrane due to unit pressure on the second, or *vice versâ*. The energy in the case of any number of membranes is in the same way easily proved to be $\frac{1}{2} \Sigma\, l\, P^2 + \Sigma\, m\, PP'$.

Consider now another case. If a small spherical cavity of radius r exist in the medium, and a small quantity of incompressible liquid q be forced into it, the consequent energy of strain of the medium is $\frac{1}{2} E \frac{q^2}{4\pi r}$ where r is the radius of the cavity. (See paper already referred

* See paper on Elastic Medium method of treating Electrostatic Theorems; read before Section A, New Zealand meeting. Phil. Mag., vol. 34, p. 18.

to.) If, now, a membrane immersed in the medium be submitted to a pressure P, the further amount of energy stored up is $\frac{1}{2}\, l\, P^2$, the same as if the cavity (r is very small) did not exist, for there is no occasion given here (as in the former case) for another pressure to do work. Thus the energy of the medium is $\frac{1}{2}\, l\, P^2 + \frac{1}{2}\, E\, \frac{q^2}{4\pi r}.$ But suppose the order of displacement to be reversed. The displacement of the membrane will cause an amount of energy $\frac{1}{2}\, l\, P^2$ to be stored up in the medium. Also the displacement will cause variations of pressure in all parts of the medium. (A uniform pressure throughout the medium does not affect matters at all, and may be supposed to exist if it be felt a difficulty that without it the displacement of the membrane will cause negative pressures on one side of it.) Let the pressure so caused in the neighbourhood of the cavity be p. If, now, the quantity q be introduced, it has to be forced into the cavity, not merely against the stress its own presence causes, but also against p. Thus the work done in forcing the liquid in is $p.q + \frac{1}{2}\frac{q^2}{4\pi r}.E.$ Whilst this is being done the membrane is pushed back a certain amount. This bears to q the ratio that the solid angle subtended by the membrane at the cavity does to 4π, say, $\frac{q\,\omega.}{4\pi}.$ This displacement takes place against P, and therefore the medium is deprived of energy to the amount $Pq\,\frac{\omega}{4\pi}.$

Thus the total energy $= \frac{1}{2}\, l\, P^2 + p\, q + \frac{1}{2}\, \frac{q^2}{4\pi r} E - P\, q\, \frac{\omega}{4\pi}.$

This must equal the value obtained before, and therefore $p = P\frac{\omega}{4\pi}.$

Thus the surfaces of equal pressure in the neighbourhood of a displaced membrane are the loci of points at which the membrane subtends equal solid angles. The lines of displacement are perpendicular to the surfaces.

These proofs and results have their exact analogues in electromagnetism. The displacement of the incompressible medium corresponds to magnetic induction; the incompressibility represents the fact that lines of induction must return into themselves, or, in other words, that the number that enter any closed space is the same as the number that leave. Just as the displacement in any direction is proportional to the rate of change of pressure in that direction, so the induction in any direction is proportional to the rate of change of magnetomotive force in that direction, the constant of proportion being the permeability. When a current runs round a circuit it exercises a uniform magnetomotive force over every unit of area of a surface (any one) drawn to have the circuit as contour.

Thus the results obtained above must have their exact analogues in magnetism, which may be proved at once from the corresponding hypothesis. I have only used the strain theory because it gives such good mental pictures.

The exact analogues are—

Displacement (d) to $\frac{\text{induction}}{4\pi}$ or $\frac{B}{4\pi}$

Pressure to magnetomotive force

E to $\frac{4\pi}{\text{permeability}}$ or $\frac{4\pi}{\mu}$

and in consequence—

Rate of change of pressure $= E\,d$	to	$H = \frac{4\pi}{\mu} \cdot \frac{B}{4\pi}$ or $B = \mu H$
Energy in unit volume $= \frac{1}{2} E\,d^2$	to	Energy in unit volume $= \frac{1}{8\pi} . H . B$

7.—SOME NOTES ON THE NEW ROYAL OBSERVATORY, EDINBURGH.

By RALPH COPELAND, Ph.D., F.R.A.S., F.R.S.E., Astronomer Royal for Scotland, and Professor of Astronomy in the University of Edinburgh.

After careful examination of the various heights surrounding Edinburgh, the committee appointed to report to the Secretary for Scotland respecting the erection of the new Edinburgh Royal Observatory, fixed on Blackford Hill, about two miles south of the centre of the city, as the most suitable site. The committee was composed of the Earl of Crawford (chairman), Lord McLaren, Professor Tait, the Queen's Remembrancer, and the Astronomer Royal for Scotland. The buildings were commenced in the autumn of 1892, and are now nearly completed. To render the following brief description more intelligible, a photograph showing all the Observatory buildings, apart from the dwelling-houses, is sent herewith.

Premising that in the accompanying photograph the spectator is looking north-west, the orientation of the buildings will be readily understood. The structure on the left is the transit-house (not quite finished), the centre line of which, of course, ranges exactly north and south. In it will be mounted the Dunecht transit-circle of 8·6 inches aperture. Indeed, the piers for this instrument, and also for its collimators, each 6·2 inches in aperture, are already in position. In designing this building every care has been taken to insure uniformity of temperature within and without, so that the instrument shall yield observations as correct as if taken in the open air, while the observer and the apparatus are completely sheltered from the wind. To this end the walls and roof are of corrugated steel in two layers, with ample ventilation between; besides which the outer wall is louvred, and to guard against the disturbing effects of radiant heat it is tinned. The coat of tin accounts for the white appearance in the picture. To prevent the escape of even slightly-warmed air-currents through the observing opening, the roof has two ridges running north and south, and is ventilated along each of these ridges at a distance of some 4 feet on either side of the opening which lies at the bottom of the depression between the ridges. To avoid confusion, it may be mentioned that the small circular building in the foreground is a detached hut containing a 12-inch reflector.

A covered way, some 80 feet in length, connects the transit-house with the western tower of the main building. In the lower story of this tower will be placed a four-fold chronograph for general use, each of its barrels being capable of recording some six hours' work. The room next above will contain charts and a small reference library for the use of the observer who is in charge of a 24-inch equatorial reflector housed in the revolving drum which caps the tower. As may be seen from the picture, this drum or dome is completely finished, as far as the outer appearance goes. It was constructed by Sir Howard Grubb, of Dublin, and is 22 feet in diameter. The framework and shutters are of steel, covered first with wood and then with copper. The photograph scarcely gives an adequate idea of the elegance and harmony of this structure; the well-known green of the oxidised copper blending most exquisitely with the pale pink of the Doddington sandstone used in the masonry, and the more delicate tracery of the pilasters and mouldings giving an exquisite finish to the whole. The cylindrical form of roof was chosen as offering the greatest facility for use in a variable climate. Nothing, indeed, can surpass its convenience as planned by the distinguished Irish engineer. The thumb and finger suffice to impart a rapid rotation to the whole roof. A single pull on a cord withdraws the side shutter into a pocket in the wall of the drum; hence all possibility of the unpleasant or dangerous rattling of the open shutter in a gale of wind is obviated. More than half the hemisphere of the heavens is now open to the observer, while he, as well as his instrument, are sheltered from any sudden downpour of rain. In case of very high wind, a revolving steel shutter can be pushed upwards to any desired height, short of obstructing the view, to exclude the violent eddies of the wind so disastrous to observations. The roof shutter "telescopes" in two parts, and can consequently be withdrawn considerably beyond the zenith without projecting at the back of the dome, where it might easily be injured by a strong wind. It is obvious that the roof shutter need only be withdrawn as much as is required by the position of the object under study or the necessities of thorough ventilation. From the chart-room of the western tower we step out on the asphalted platform connecting the two towers. The most beautiful panorama of Edinburgh lies before us—from the Salisbury Crags to the Corstorphine Hills, with the castle rising grandly in the centre. This platform is more than 100 feet in length by fully 20 in breadth. From one part or other practically the whole of the sky can be scanned, as an extension to the south in the centre allows the observer to move out of the line of the domes. When the photograph was taken, near the end of October, 1894, the workmen were still engaged on the eastern dome. Now that it is nearly finished, it can be seen that it will be fully as ornamental as its neighbour. It will contain the 15-inch achromatic refractor from Dunecht, a telescope as complete in its appliances as any in existence; being provided with electric control, slow motions from the eye-end, micrometer with independent illumination of right-ascension and declination wires, spectroscopes, solar eye-pieces with which the full aperture of the glass may be used with absolute safety, &c., &c. Immediately beneath the floor of the dome is another small chart-room.

Opening from the platform to the south is, perhaps, the most interesting room in the whole observatory—the optical-room, measuring 66 feet from north to south by 24 feet in width. The zinc-covered roof is well shown in the photograph; it is kept as low as possible to avoid obstructing the view of the heavens from the platform. This room can be completely darkened at a moment's notice, while a pencil of rays fully ten inches in diameter, emanating from any celestial object—including the sun—can be thrown along the centre of the room by a Foucault siderostat on the platform. The rays enter the optical-room by a window in the northern wall. Into this window can be fitted, by self-adjusting contrivance, any of the object glasses belonging to the observatory. The images formed by these lenses can be examined by spectroscopes, eye-pieces, &c., mounted on massive iron tables capable of accurate adjustment. These tables run on one or other of four systems of rails carried by steel girders independent of the floor. Two pairs of rails are for the study of central rays, while the other two support apparatus for the reception of rays deflected by prisms on gratings.

The ground floor of the building between the towers is taken up with a small spectroscope-room, laboratory, electrical-room, cleaning-room, mechanics' workshop, and instrument-room; while in the eastern tower on the same level is a computing-room and a suite of photographic rooms.

On the ground floor towards the south, under the optical-room, are the director's room, an anteroom, a computing-room, and the library. The latter is a fine apartment, 34 feet by 23 feet 9 inches, and being on a lower level than the rest of the rooms is sufficiently high to admit of a light gallery running round the wall. Here will be arranged the magnificent Crawford Library of astronomical and mathematical works, to which many recent presents and purchases, as well as many valuable works belonging to the Edinburgh Royal Observatory, have been added.

In the basement are sundry store-rooms, a joiner's workshop, the heating apparatus, and a large room for electrical batteries.

The two equatorial instruments already mentioned are carried by massive brick piers built with cement. In the base of the larger of these is a small chamber, in which will be placed the two normal clocks of the observatory. The best of these was the gift to the Edinburgh Royal Observatory of General Sir Thomas Makdougall Brisbane, whose memory is specially dear to scientific Australasians as the founder of the first observatory in Australia, and whose name is preserved in that of the flourishing city where your Association holds its meeting. The outer case of the clock bears the inscription, "Sidereal governing clock, presented to R. Observatory, Edinburgh, by General Sir Thomas Makdougall Brisbane, Bart., 1855." Thirty-nine years is but a short period in the life of a first-class astronomical clock, and, as far as can be judged, this masterpiece of Dent's workmanship is still as good as when first received at the observatory. There is nothing special in its design, except that it has contact wheels on the 'scape wheel arbor for transmitting electric currents every second (positive and negative alternately) through a series of controlled clocks. These wheels act upon springs, and do not affect in the slightest degree the motion of the pendulum.

By the month of April, 1895, it is expected that the tradesmen will have completed the building, and the work of placing the instruments in position can begin. It is hoped that the principal instruments will be in working order when the long nights set in, and that the observatory may take its part in helping to solve the astronomical problems of the day.

8.—THE MAINTENANCE OF SOLAR ENERGY.

By His Grace The ARCHBISHOP of HOBART.

9.—WHY DO WE NOT TAKE A DEEPER INTEREST IN ASTRONOMY?

By Rev. THOS. ROSEBY, M.A., LL.D.

10.—CONJECTURE AS TO THE PRESENT STAGE OF THE LIFE HISTORY OF MARS, FROM COMPARISONS OF THE EARTH, MOON, AND MARS.

By J. EWEN DAVIDSON, M.A., Oxon.

11.—ADVANCEMENT OF ASTRONOMY IN THE SOUTHERN HEMISPHERE.

By R. T. A. INNES, F.R.A.S.

12.—A PROPOSED METEOROLOGICAL STATION ON MOUNT WELLINGTON.

By H. KINGSMILL, The Observatory, Hobart.

Edinburgh New Royal Observatory October 1894 From the S W

Section B.

CHEMISTRY.

1.—VARIATION IN THE AMOUNT OF FREE AND ALBUMINOID AMMONIA IN WATERS, ON KEEPING.

(ILLUSTRATED BY CURVES.)

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, N.S.W.

In the course of an investigation into the quality of the Sydney Water Supply, 1875, I had noticed variations in the amounts of ammonia after keeping, and in order to obtain satisfactory and trustworthy data with respect to such changes—*i.e.*, as far as they were determinable by Mr. Wanklyn's process—samples of water were put up with the utmost care, and the amount of ammonia determined from time to time; a separate bottle being opened for each determination.

When waters were artificially made impure, the admixture was effected in a large glass pan, well stirred and otherwise mixed, and then transferred to clean clear quart bottles which were filled to the top, and the excess squeezed out by the stopper.

The results in the following tables show very clearly that, in some cases, the amounts of free and albuminoid ammonia increase and then decrease, and occasionally increase again; these changes are much more strikingly shown in the curves than in the tables. Until decomposition and other natural changes have taken place, the potassium permanganate process fails to set free a large proportion of the albuminoid ammonia from the organic matter, so that a water might wrongly be declared pure, if examined when freshly collected or after lengthened keeping.

These following series of experiments were carried out as far back as 1876, with the aid of my then assistant, Mr. J. M. Muir, afterwards University demonstrator.

I have hitherto refrained from publishing this investigation, as I had hoped to extend the results in other directions; but as it may be some time before additional experiments can be undertaken, I present those already obtained. These, however, as far as they go, show how very important it is that the reports on the analysis of water should state how many days, weeks, or months have elapsed since the samples were collected.

The temperatures given in the table were taken at 9 to 10 a.m. and 4 to 5 p.m.; they were recorded, because more rapid changes might be expected in warm than in cold weather.

I may remark that the determinations were made as recommended by Mr. Wanklyn, and that the sodium carbonate used for the free ammonia, and the potash and potassium permanganate used for the albuminoid ammonia, were boiled until they yielded distillates free from ammonia, and the distilled water used was also distilled from potash and potassium permanganate until free from ammonia.

TABLE No. 1.

NINE BOTTLES each of GARDEN TANK, LABORATORY TANK, and DISTILLED WATER. Put up on 9th October, 1876.

Temperature (Fahrenheit).		—		Garden Tank.		Laboratory Tank.		Distilled Water.	
				Parts per 1,000,000		Parts per 1,000,000.		Parts per 1,000,000.	
Morning.	Evening.	Nos.	Date.	Free NH_3.	Alb. NH_3.	Free NH_3.	Alb. NH_3.	Free NH_3.	Alb. NH_3.
68°	70°	1	October 11 ...	·01	·09	·35	·184	·07	·04
68°	70°	2	,, 12 ...	·005	·042	·25	·08	·09	·036
68°	69°	3	,, 13 ..	·01	·04	·24	·094	·05	·03
65°	66°	4	,, 14 ...	·01	·04	·22	·11	·07	·03
67°	67°	5	,, 16 ...	·01	·054	·23	·096	·04	·01
71°	71°	6	,, 17 ...	·01	·04	·23	·08	·04	·005
70°	68°	7	,, 19 ...	·005	·03	·22	·06	·04	·005
70°	70°	8	,, 20 ...	·005	·02	·22	·084	·03	·005
71°	70°	9	,, 21 ...	·005	·02	·21	·07	·005	·005

In all of these, with slight variations, there was gradual improvement on keeping.

The laboratory tank (in the roof) at the time of these experiments was supplied with rain-water from the slate roof of the main building. The garden tank (underground) was also supplied from the same source. It is noticeable that there are considerable differences between the laboratory tank and the underground garden tank waters, although both from the same roof.

TABLE No. 2.

FIVE BOTTLES each of GARDEN TANK, LABORATORY TANK, and DISTILLED WATER. Put up on 18th October, 1876.

Temperature (Fahrenheit).				Garden Tank.		Laboratory Tank.		Ordinary Distilled Water.	
Morning.	Evening.	Nos.	Date.	Free NH_3	Alb. NH_3	Free NH_3	Alb. NH_3	Free NH_3	Alb. NH_3
67°	65°	1	Oct. 18	·005	·04	·018	·07	·036	·002
70°	68°	2	,, 19	·005	·03	·13	·06	·030	·005
72°	70°	3	Nov. 1	·005	·01	·15	·06	·005	·005
76°	78°	4	,, 16	·005	·01	·15	·06	·005	·005
71°	73°	5	,, 20	·005	·005	·14	·06	·000	·005

NOTE.—Heavy rain fell for about two hours on the morning of the 18th, just before collecting these samples.

TABLE No. 3.

SEVEN BOTTLES each of GARDEN TANK, LABORATORY TANK, and DISTILLED WATER. Put up on 23rd October, 1876.

Temperature (Fahrenheit).		—		Garden Tank.		Laboratory Tank.		Distilled Tank.	
Morning.	Evening.	Nos.	Date.	Free NH_3	Alb. NH_3	Free NH_3	Alb. NH_3	Free NH_3	Alb. NH_3
72°	70°	1	Nov. 1	·005	·01	·06	·04	·005	·005
72°	75°	2	,, 21	·005	·005	·04	·05	·005	·005
74°	76°	3	,, 22	·005	·005	·04	·04	·01	·005
75°	76°	4	,, 23	·005	·005	·04	·05	·01	·005
68°	67°	5	,, 25	·005	·005	·06	·05	·005	·005
68°	69°	6	,, 28	·005	·005	·07	·03	·005	·005
67°	68°	7	,, 30	·005	·005	·06	·03	·005	·005

NOTE.—No rain since 18th October.

TABLE No. 4.

FIVE BOTTLES each URINE and HORSE POND WATERS.

Temperature (Fahrenheit).		—	—	Horse Pond.		Urine and Distilled Water.	
Morning.	Evening.	Nos.	Date.	Free NH_3.	Alb. NH_3.	Free NH_3.	Alb. NH_3.
70°	72°	1	Nov. 3	·35	·08	·09	·12
74°	76°	2	,, 7	·20	·08	·18	·12
74°	76°	3	,, 11	·05	·08	·18	·12
74°	76°	4	,, 13	·05	·08	·19	·11
75°	75°	5	,, 14	·03	·07	·21	·12

NOTE.—Rain on 11th November.

In all cases where mixtures gave such large amounts of ammonia as to be unworkable, they were, before distilling, diluted with the requisite quantity of distilled water to bring the ammonia down to working limits.

The second of the above series (urine and distilled water) did not contain enough bottles; the amount of free ammonia increased from ·09 to ·21 in eleven days. If the experiment could have been carried on longer, a larger amount of ammonia might have been set free.

TABLE No. 5.

FIVE BOTTLES each URINE and HORSE POND WATER.

Temperature (Fahrenheit).		—	—	Horse Pond.		Urine and Distilled Water.	
Morning.	Evening.	Nos.	Date.	Free NH_3.	Alb. NH_3.	Free NH_3.	Alb. NH_3.
76°	76°	1	Nov. 16	·60	·18	·56	·56
72°	75°	2	,, 21	·01	·13	1·20	·39
74°	76°	3	,, 22	·01	·13	1·28	·35
72°	72°	4	,, 24	·01	·11	2·56	·29
66°	69°	5	,, 27	·01	·11	1·60	·32

NOTE.—Rain on 11th November; none since.

In the second series containing urine, the gradual increase and then decrease of free ammonia is very marked, the decrease of albuminoid ammonia going on very regularly.

TABLE No. 6.

TWELVE BOTTLES GARDEN TANK WATER and URINE.

Temperature (Fahrenheit).		Nos.	Date.	Free NH_3.	Alb. NH_3.
Morning.	Evening.				
72°	77°	1	Nov. 24	·27	·27
66°	69°	2	,, 27	·32	·18
66°	68°	3	,, 29	·20	·18
67°	68°	4	,, 30	·20	·18
68°	68°	5	Dec. 1	·16	·15
66°	71°	6	,, 4	·28	·36
73°	73°	7	,, 6	·36	·40
76°	77°	8	,, 7	·24	·27
77°	78°	9	,, 8	·17	·15
73·5°	75°	10	,, 11	·16	·14
77°	76°	11	,, 12	·14	·13
71·5°	72°	12	,, 13	·13	·10

NOTE.—No rain from the 11th November.

If only the last two bottles of the above had been examined, the impression conveyed would have been very different to that from the earlier and intermediate ones—hence a very seriously contaminated water (if the ammonia tests be solely relied upon) might, if a few weeks in transit to the examiner, be passed as a fair or even good water.

TABLE No. 7.

DISTILLED WATER and WHITE of EGG.

About 1 gramme of white of egg was diffused as uniformly as possible, first through a small quantity and then through a large volume of distilled water, and nine quart bottles filled up with the mixture.

Temperature (Fahrenheit).		Nos.	Date.	Free NH_3.	Alb. NH_3.
Morning.	Evening.				
72°	72°	1	Nov. 24	·33	·37
66°	69°	2	,, 27	·33	·49
66°	68°	3	,, 29	·50	·56
67°	68°	4	,, 30	·40	·60
68°	68°	5	Dec. 1	·40	·70
66°	71°	6	,, 4	·60	·70
73°	73°	7	,, 6	·60	·77
76°	77°	8	,, 7	·60	·72
77°	78°	9	,, 8	·50	·80

It will be noticed in the above table that the amounts of both free and albuminoid ammonia increased very greatly after four or five days, showing that the fresh albumen, like urine, does not yield ammonia so readily as that which is more or less decomposed. As the amount of albuminoid ammonia had increased in the ninth and last bottle, a larger series would have been more satisfactory.

TABLE No. 8.

EIGHT BOTTLES each of GARDEN TANK WATER and NH_4NO_3, and DISTILLED WATER and NH_4NO_3. (Rained heavily for 24 hours before putting up this series.)

Temperature (Fahrenheit.)		—		Garden Tank Water and NH_4NO_3.		Distilled Water and NH_4NO_3.	
Morning.	Evening.	Nos.	Date.	Free NH_3.	Alb. NH_3.	Free NH_3.	Alb. NH_3.
75°	76°	1	Nov. 17	·46	·09	·40	·09
75°	76°	2	,, 23	·36	·05	·32	·05
66°	69°	3	,, 27	·04	·05	·30	·09
68°	69°	4	,, 28	·03	·04	·48	·11
66°	68°	5	,, 29	·03	·04	·48	·07
67°	68°	6	,, 30	·03	·04	·40	·11
68°	68°	7	Dec. 1	·03	·04	·48	·11
66°	71°	8	,, 4	·02	·04	·50	·09

It will be noticed that the distilled water containing ammonium nitrate yielded nearly equal amounts of free albuminoid ammonia all through the series; but when mixed with the garden tank water, the free ammonia was reduced very greatly, to about $\frac{1}{11}$, and the albuminoid ammonium to about $\frac{1}{2}$ in the course of ten days, showing that a great change had taken place, due to decomposition or to the action of organisms, or to both.

TABLE No. 9.

TEN BOTTLES each of HORSE POND and FISH POND WATERS, UNDILUTED.

Temperature (Fahrenheit).		—		Horse Pond.		Fish Pond.	
Morning.	Evening.	Nos.	Date.	Free NH_3.	Album. NH_3.	Free NH_3.	Album. NH_3.
			1876.				
73°	75°	1	Dec. 11	10·00	7·00	·12	·90
77°	78°	2	,, 12	2·00	2·00	·11	·92
71·5°	73°	3	,, 13	8·00	4·00	·16	1·04
76°	78°	4	,, 15	7·00	4·00	·16	1·03
80°	78°	5	,, 16	6·00	2·00	·38	·69
74°	75°	6	,, 19	5·00	2·00	·52	·56
76°	77°	7	,, 20	4·00	1·00	·70	·38
75°	76°	8	,, 21	2·00	·50	·90	·30
			1877.				
75°	75°	9	Jan. 8	·50	·25	1·38	·06
73°	74°	10	,, 10	·07	·07	1·50	·04

NOTE.—On account of the large quantity of organic matter, only 10c.c. of Horse Pond water was used in each instance for determination; this was diluted in retort with distilled water free from NH_3. Used the usual half-litre for Fish Pond water.

TABLE No. 10.

SEVEN BOTTLES each GARDEN TANK and PEATY MATTER, and GARDEN TANK and AMMONIA SOLUTION.

Temperature (Fahrenheit).		—		Garden Tank and Peaty Matter.		Garden Tank and Free NH_3.	
Morning.	Evening.	Nos.	Date.	Free NH_3.	Album. NH_3.	Free NH_3.	Album. NH_3.
			1876.				
73°	75°	1	Dec. 11	·72	·19	2·8	·20
77°	78°	2	,, 12	1·12	·04	2·80	·20
71·5°	73°	3	,, 13	1·12	·13	2·72	·23
76°	78°	4	,, 15	1·08	·12	2·70	·21
80°	78°	5	,, 16	·03	·04	·64	·10
74°	75°	6	,, 19	·02	·03	·56	·07
76°	77°	7	,, 20	·01	·01	·20	·01

The self-purification of the above samples is very remarkable.

2.—ON THE CORROSION OF ALUMINIUM.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, New South Wales.

In order to ascertain the effects of the weather upon ordinary sheet aluminium, two shallow dishes were made of 1 mm. or $\frac{1}{25}$-inch gauge metal, and exposed on the roof of the chemical laboratory of this University from 23rd November, 1893, to 7th December, 1894, or fifty-four weeks.

The metal was made into basins, so as to catch rain-water and to give the salts, &c., which it might have in solution a longer time to act upon the metal.

The metal very soon lost its brilliancy, and became somewhat rough and speckled with grey spots mixed with larger light-grey patches; it also became rough to the touch. The grey parts could be seen to distinctly project above the surface, and under the microscope they presented a blistered appearance. This incrustation is held tenaciously and does not wash off, neither is it removed on rubbing with a cloth.

The raised parts are probably due to the formation of a hydrated oxide, but I am leaving the determination of the composition of this until I have a larger quantity at my disposal.

Contrary to my expectations, the cups had not lost weight, but had even increased.

One weighing 13·91 grammes had increased by ·104 gr., and the other, weighing 13·865 gr., increased by ·080 gr. After boiling in water for some hours and rubbing, the first still showed an increase of ·077 gr., and the second of ·055 gr.

To ascertain the effects of common salt, a plate of the same metal, 3 x 4 inches, and weighing 19·829 gr., was repeatedly dipped in a solution of sodium chloride, and allowed to dry; the alternate dipping and drying was repeated almost daily for three months; the plate lost ·019 gr., and after washing and rubbing dry ·059 gr.

My reason for making these experiments is that Mr. H. C. Russell, C.M.G., F.R.S., the Government Astronomer, some years ago tried aluminium cups for a rain-gauge, but found that they were so quickly corroded through that he had to relinquish the use of the metal. If they had been gilt they might, however, have answered well enough. Then, too, it is a very common thing to see aluminium recommended for certain architectural work on account of its lightness and its assumed permanent lustre, this assumption being due to the statements, repeated from book to book, that aluminium is unaltered by exposure to the air, that it is unacted upon by water, hydrogen sulphide, and only slightly by dilute acids—even in modern special treatises such as "Aluminium," by Joseph W. Richards, M.A., London, 1890.

The absolutely pure metal may be permanent in the air, but the best aluminium ordinarily obtainable is in that respect very little, if at all, superior to zinc.

Recently it has been found that sea-water acts upon aluminium with some quickness, hence it is not so perfect a material for torpedo and other boats as was previously thought.

Hence the prevalent idea that aluminium is a metal resembling gold or silver in the property of not oxidising must be relinquished.

3.—CRYSTALLISED CARBON DIOXIDE.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, N.S.W.

When solid carbon-dioxide is examined under the microscope it presents along its edges projecting wire-like crystals, which have branching filaments issuing from them, apparently at right angles, resembling somewhat the groups of minute crystals seen in crystallised iron, gold, and ammonium chloride.

The rapidity with which the carbon-dioxide evaporates makes it difficult to catch the form of the crystals, either by photography or other means.

4.—ON THE INTERNAL STRUCTURE OF GOLD NUGGETS.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, N.S.W.

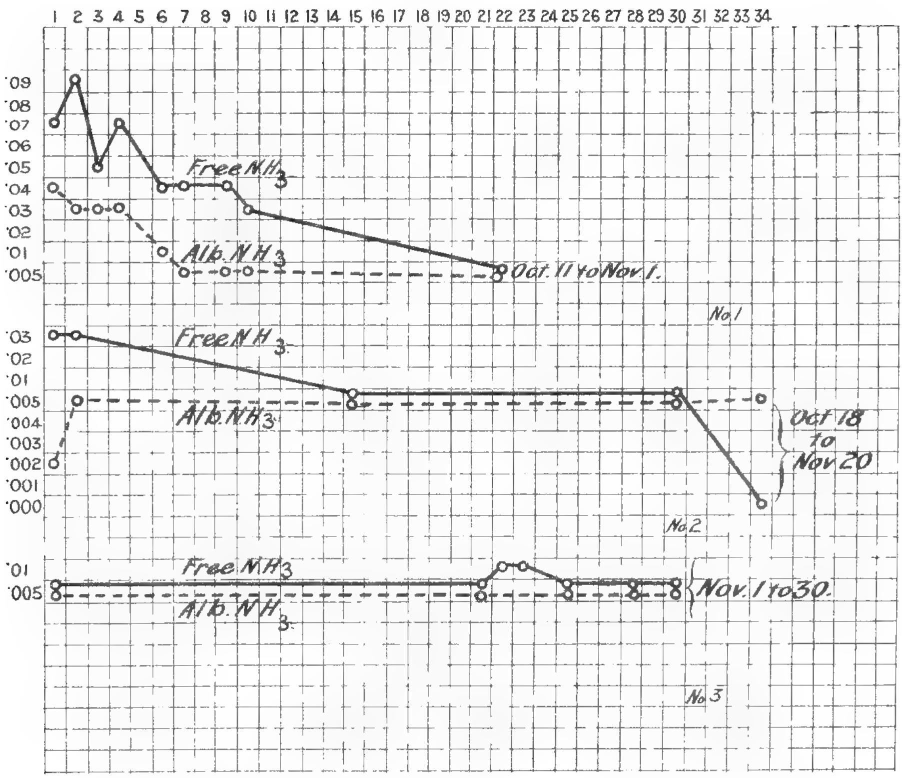
5.—CONTRIBUTIONS TO THE BIBLIOGRAPHY OF GOLD.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney.

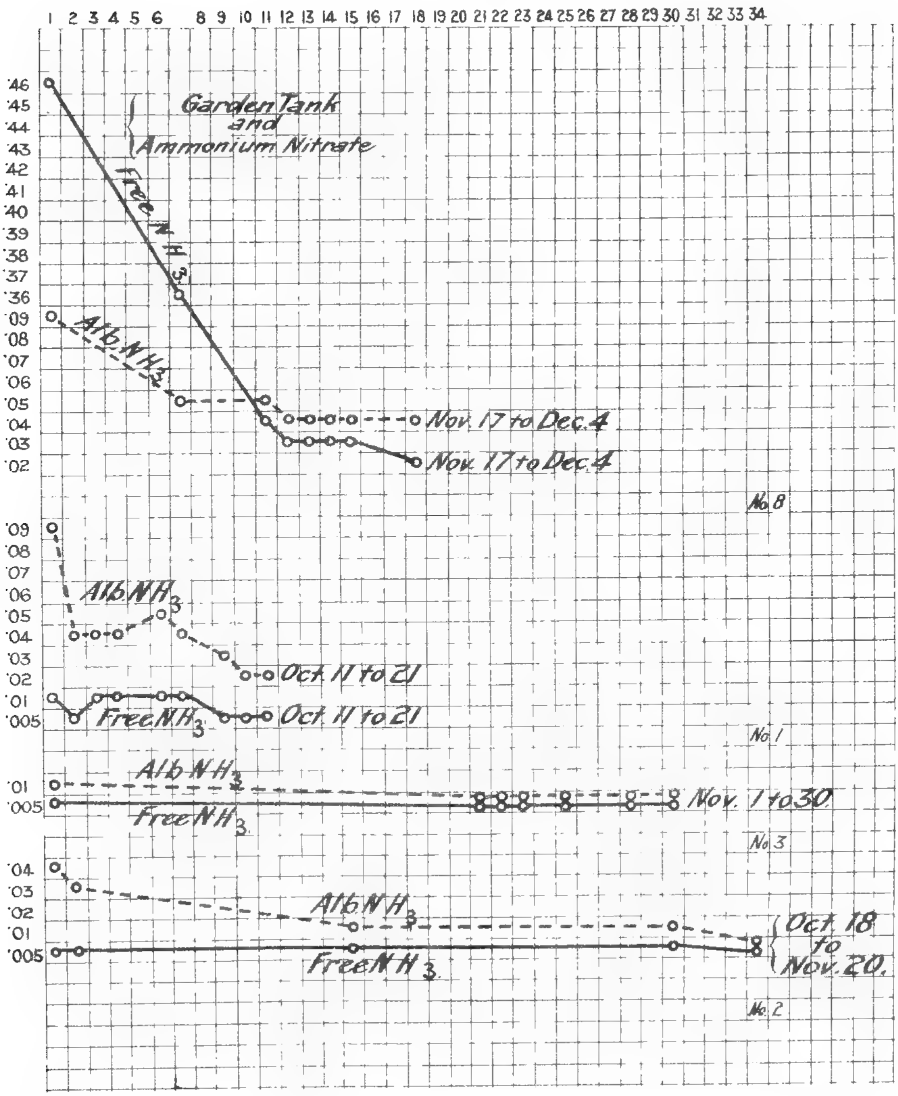
The following pages contain the titles of various books and papers upon the subject of gold which I have recorded in the course of my work upon the origin of gold nuggets, &c., and which are not contained in the Bibliography of Gold published in Locke's Gold (London, 1882):—

AARON, C. H. Leaching Gold and Silver Ores. San Francisco, 1881.
— Assaying, in three parts. San Francisco, 1884-5.

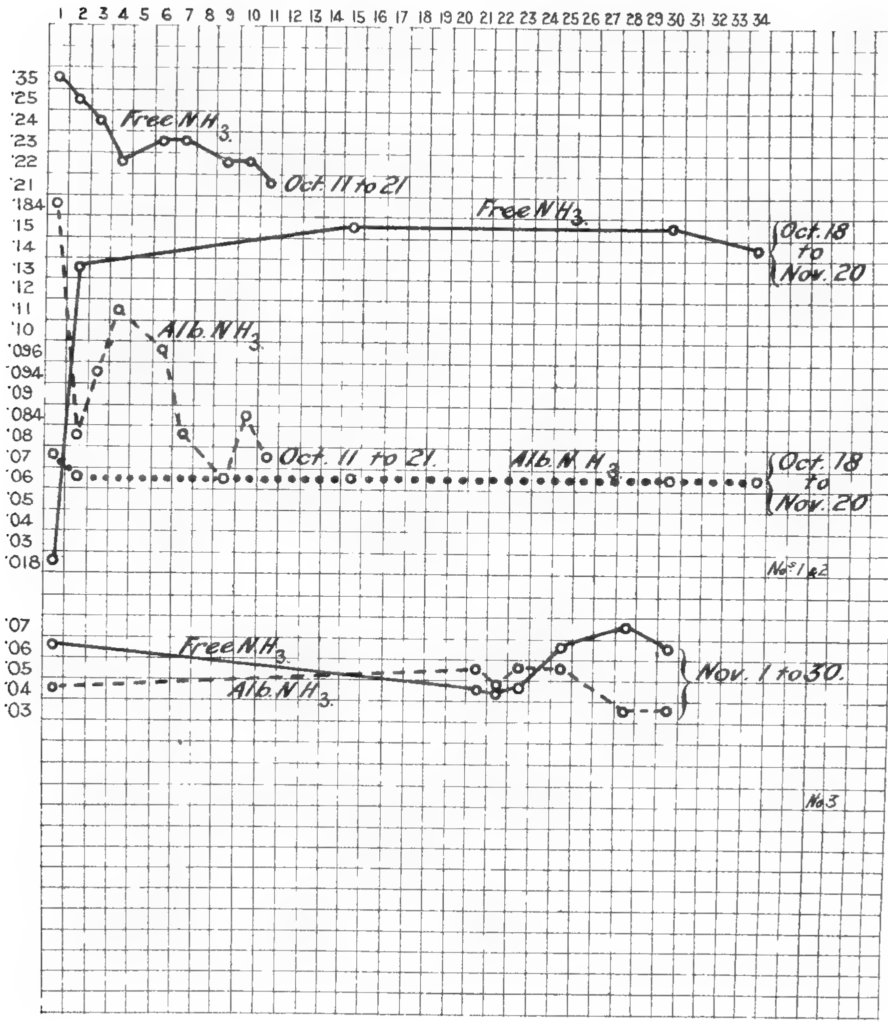
DISTILLED WATER



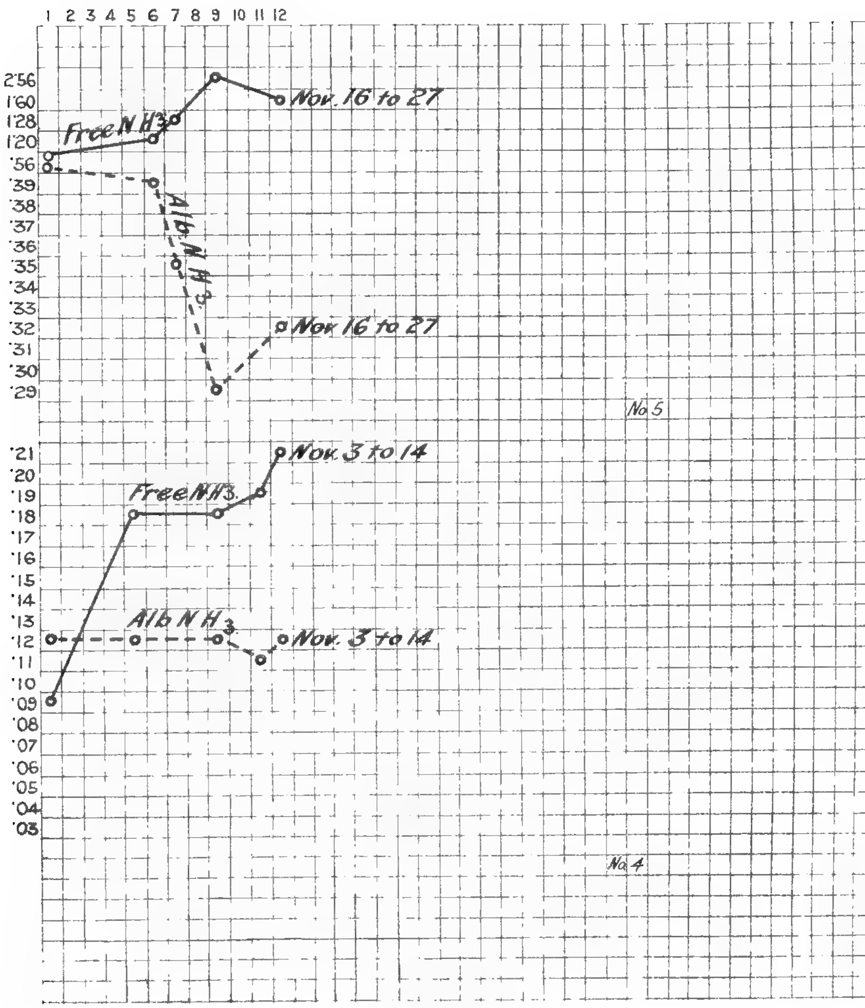
GARDEN TANK WATER



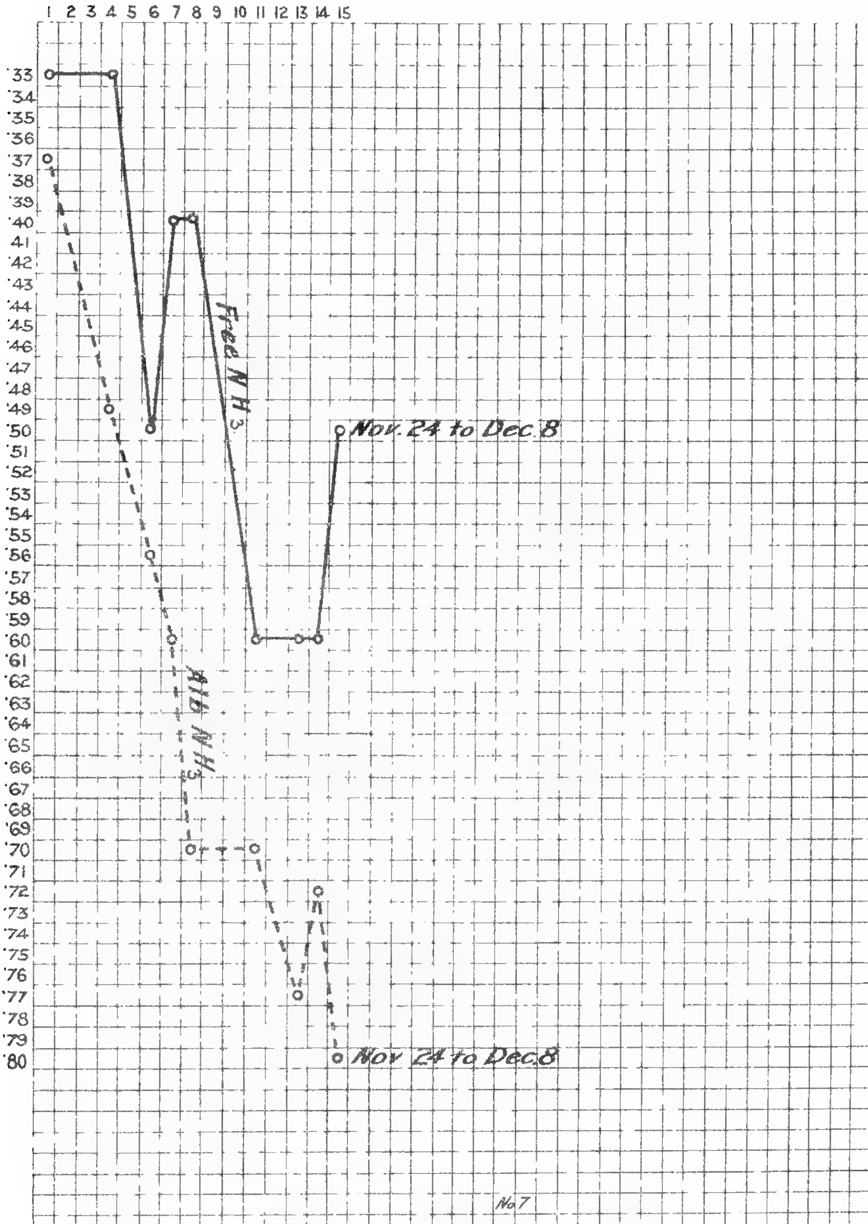
LABORATORY TANK WATER



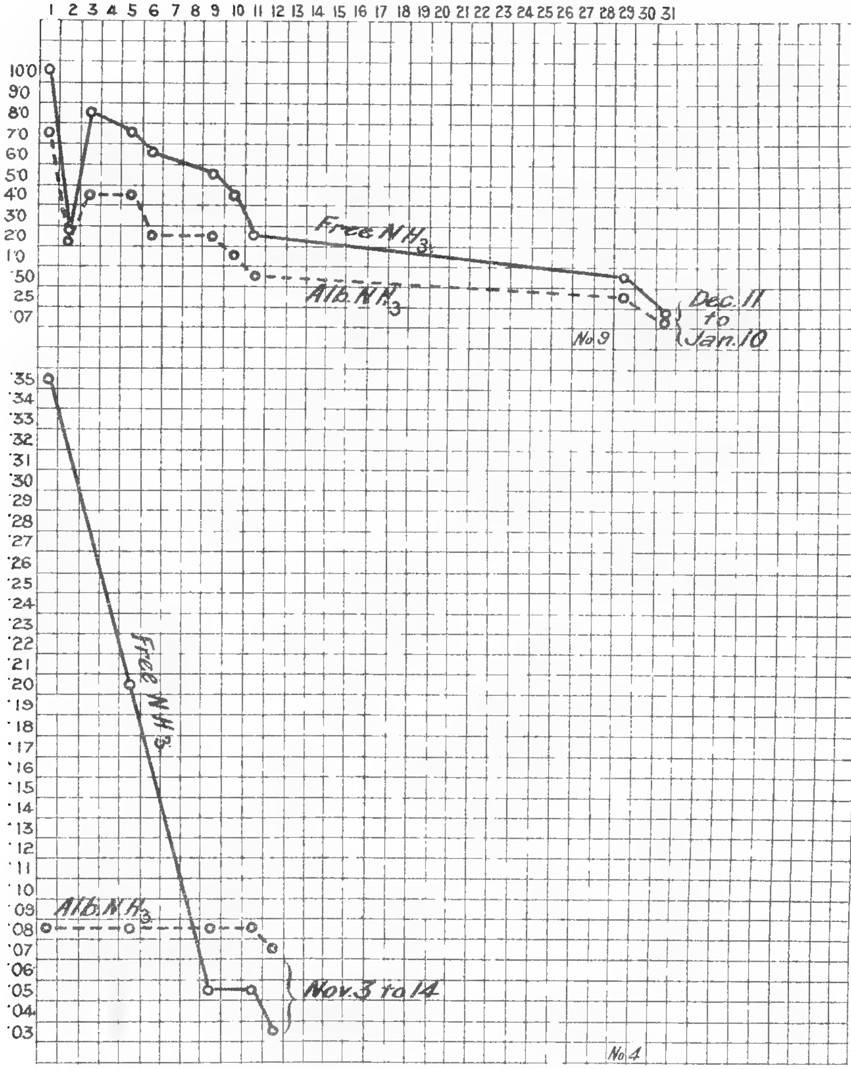
URINE AND DISTILLED WATER



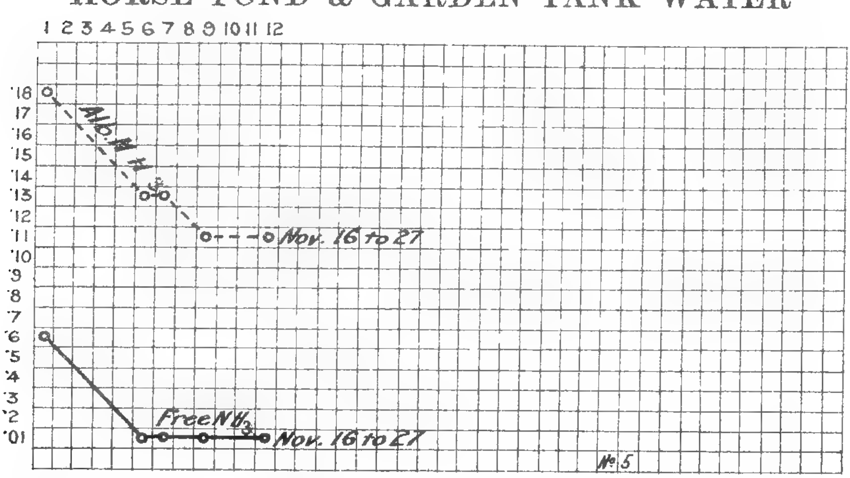
DISTILLED WATER AND WHITE OF EGG



HORSE POND WATER



HORSE POND & GARDEN TANK WATER



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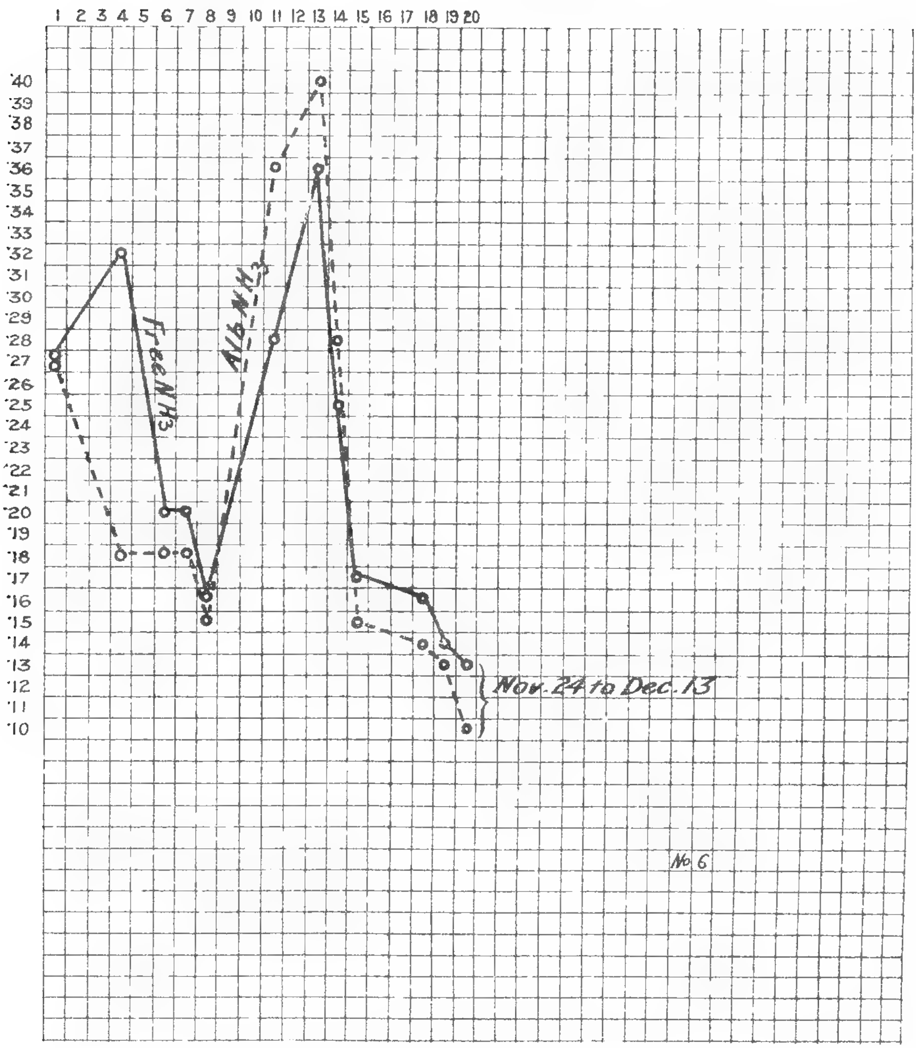

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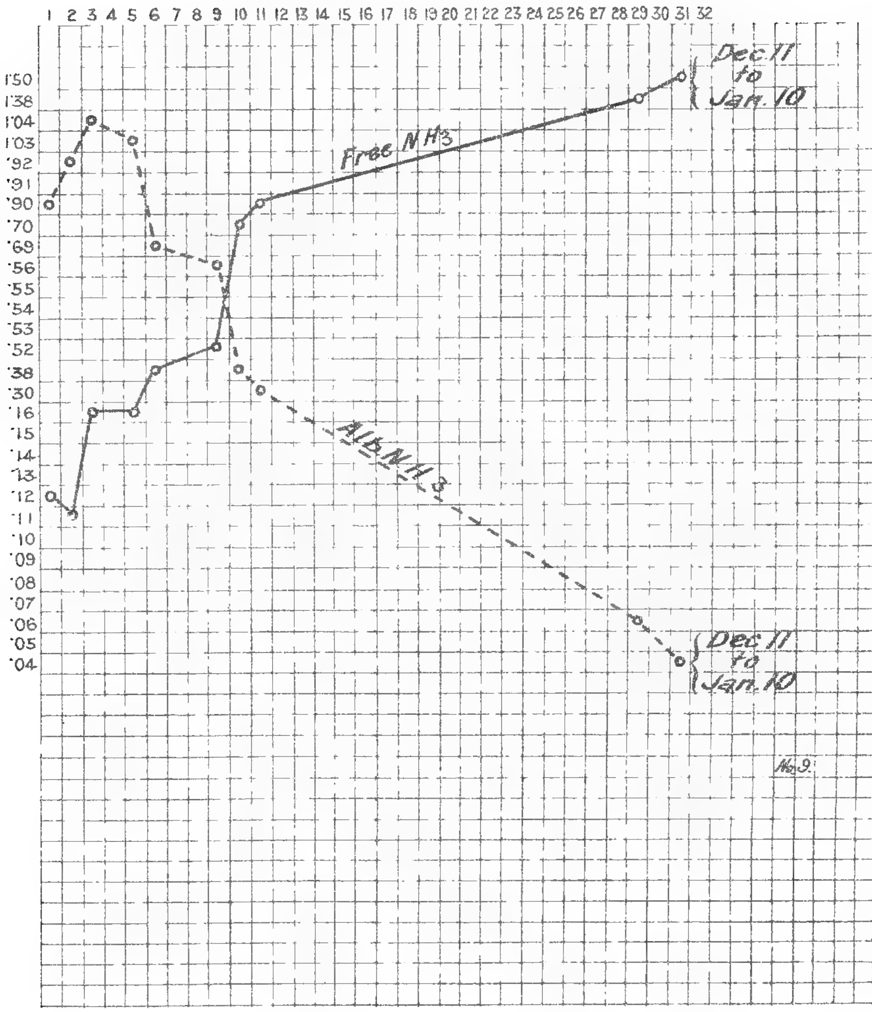
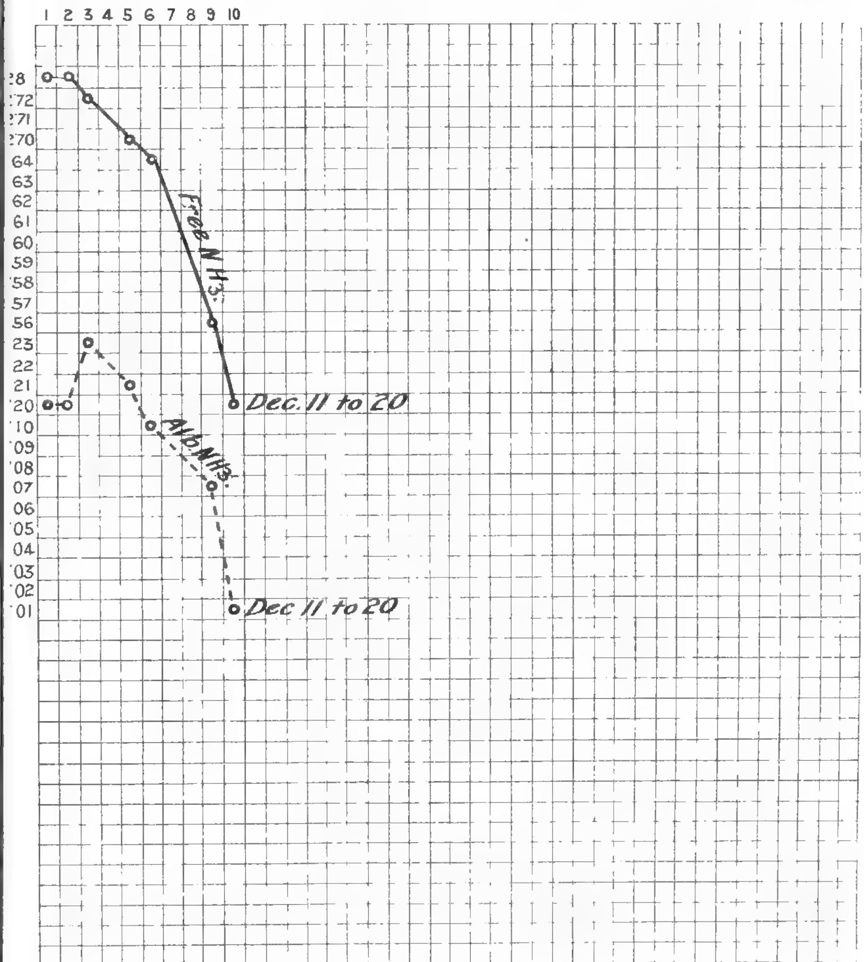
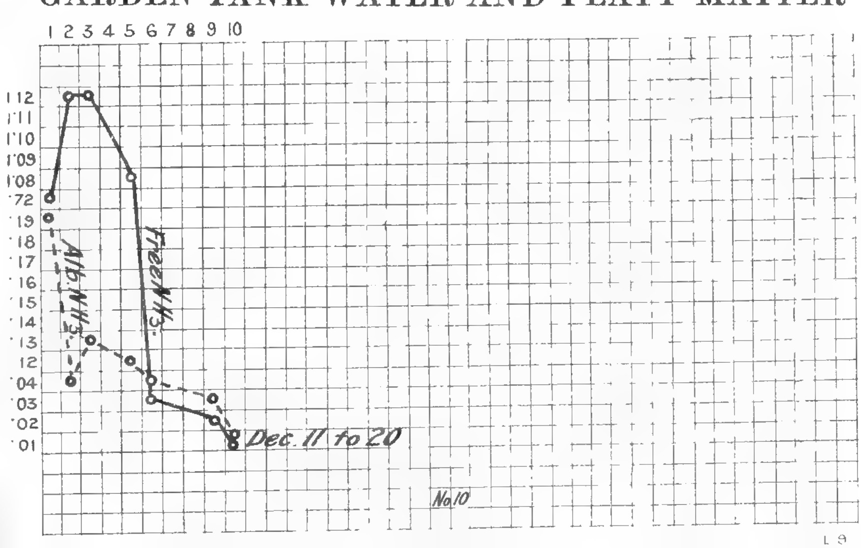


GARDEN TANK WATER & FREE AMMONIA



GARDEN TANK WATER AND PEATY MATTER



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6.—THE REFRACTORY GOLD ORES OF QUEENSLAND.—THEIR SOURCES AND TREATMENT.

By E. A. WEINBERG, M.E.

The term "refractory gold ores," as used in this paper, is intended to designate those ores which will not yield their gold, or only a small portion of it, to the ordinary treatment by amalgamation on copper plates.

Their occurrence is a general one, as every goldfield in Queensland is producing more or less refractory ore, either massive, or distributed through the quartz, as auriferous iron, arseno- and copper pyrites, as auriferous sulphide of lead, bismuth, antimony, and zinc, and finally as telluride.

No exact data are available to show in what quantities these ores have been mined, or in what proportion they have been present in the original crushing material, as it is only during the last five or six years that anything like a systematic treatment has been initiated to deal with them in a rational manner. Even to-day the Queensland system of gold-milling may give rise to more or less adverse criticism from the standpoint of modern American or South African gold-milling practices, particularly so in regard to the treatment of tailings carrying payable quantities of gold enclosed by pyrites and other base metal sulphides.

In the course of this paper the writer will endeavour to point out where and how the present system may possibly be improved upon.

For convenience' sake, the following classification has been adopted:—

A. Refractory gold ores, *massive*, carrying 40 per cent. and over of pyrites or other sulphides.

B. Concentrates of pyrites and other base metal sulphides, with 80 per cent. and more of mineral.

C. Tailings, either as such or roughly concentrated with a few per cent. of sulphurets up to 40 per cent.

D. Comparatively rich ores, with none or very little sulphurets, which, though really free gold ores, will not yield their gold in a fair percentage to ordinary amalgamation.

E. Argentiferous ores and exceptional ores.

A.—MASSIVE AURIFEROUS SULPHIDE ORES WITH 40 PER CENT. AND MORE OF PYRITES, &c.

Wherever these ores occur in quantities, the first attention should be directed to ascertaining if any coarse gold is present. Should repeated panning tests have proved the absence of coarse gold, the value of the ore is then determined by assay, in order to obtain a guidance in regard to subsequent treatment. In most cases which have come under my special notice during a six years' acquaintance with Queensland ores, it will recommend itself to separate the heavily mineralised portion from the bulk of the crushing stuff by simple hand picking, and to deal with it separately.

Frequently these ores have, besides the gold, a further commercial value, owing to the presence of either payable quantities of lead or copper.

In regard to the prevailing character of the mineral compounds which have been encountered, it may be stated that the greater bulk was decidedly of a complex nature, containing a number of different base metal sulphides combined.

As it would go beyond the limits of this paper to give the particulars of each individual ore which has been treated, the writer will confine himself to a few examples which have been selected as types for either a special district or a special mine.

Charters Towers and *Ravenswood* undoubtedly produce the greatest quantity of massive sulphide ores amongst the Queensland goldfields, although, as a rule, a separation of the heavy mineralised portion from the ordinary crushing material is very rarely practised.

About 8 tons of a massive sulphide ore, coming from the Day Dawn P.C. Company, Charters Towers, consisted of—

Iron pyrites	57·9
Galenite	11·5
Zincblende	8·6
Silica	22·0
	100·0

Assay, about 10 oz. gold per ton.

Another mine, the New Towers Extended, produced a few years ago some 300 tons of a complex ore, consisting likewise of iron pyrites, zincblende, and some galenite, and averaged 3·25 oz. of gold per ton. Its average composition was as follows:—

Iron pyrites	61·2
Zincblende	21·0
Galenite	2·2
Silica	15·6
	100·0

A smaller parcel of about 1 ton 18 cwt., from the New Imperial Mine, consisted mainly of iron and arseno-pyrites, with 45 per cent. SiO_2, and assayed 8·4 oz. of gold per ton.

At *Ravenswood* the principal source of a heavy mineral ore is the No. 1 South New England Gold Mine, which quite recently has produced over 150 tons, assaying from 2·5 oz. up to 5·65 oz. of gold per ton, the general composition of which may be represented by the following analysis:—

Iron pyrites	34·3
Copper pyrites	4·8
Zincblende	19·1
Alumina	4·3
Silica	37·5
	100·0

From the *Mount Perry district* the writer has dealt with 20 tons of a heavy mineral ore from the Lady Norman, and 41 tons from the Reid's Creek Mine. The ore in both cases carried a little over 40 per cent. of mineral, principally iron and arseno-pyrites, with a little galenite and sulphide of antimony. The gold contents varied between 2·25 oz. and 5·05 oz. per ton.

A mine *near Cania* (Gladstone district) shipped a few years ago several tons of a heavy complex ore, containing arseno-pyrites, copper pyrites, and some zincblende assaying about 7 oz. of gold per ton.

A further parcel of 5 tons 10 cwt., which likewise came from the *Gladstone district*, consisted of arseno- and copper pyrites, and assayed 3·4 oz. per ton.

The only parcel consisting of a few tons of auriferous copper pyrites which has come under the writer's notice was produced in the *Rockhampton district*, and assayed 4·15 oz. of gold per ton.

From the *Kilkivan district* about 14½ tons of an iron arseno-pyrite have lately been treated, which assayed 3·45 oz. of gold per ton.

The only district represented by auriferous antimonial sulphide is Cooktown, from whence a few tons containing 53·1 per cent. antimony sulphide, and assaying 3·65 oz. of gold per ton, have been shipped a few years ago.

At *Mount Shamrock* a rich massive mineral ore, containing metallic bismuth and the selenides and tellurides of bismuth, is being mined.

B.—CONCENTRATES WITH 80 PER CENT. AND MORE OF SULPHURETS.

It must be pointed out here that very little progress has been made in Queensland towards producing clean concentrates from tailings; and the reason for this apparent failure is probably found in the Queensland system of gold-milling itself, as well as in an often wrongly applied economy. In most of the Queensland mills the roughly concentrated tailings are still being worked in grinding pans; and though it must be admitted that under favourable conditions a fair extraction of the gold contents may be effected, it is equally certain that, wherever chlorination and smelting works are in easy reach, it will be far more economical to adopt a perfect concentration of the tailings at once, so as to produce clean but also richer concentrates.

The Queensland Under Secretary for Mines, in his well-tabulated Annual Report for 1893, gives the number of crushing mills as follows:—

In operation	114
Idle	51
Total number of stamps	1,861

This would allow us the low average of $11\frac{3}{10}$ stamps for each mill, which for that particular year can only be shown having crushed $208\frac{7}{10}$ tons per stamp per year, or $\frac{69}{100}$-ton per stamp per day. In arriving at these figures 389,000 tons have been calculated as being reduced by stamps, while 64,923 tons (approximately) have been crushed in a dry state by means of rollers, principally at Mount Morgan and Ravenswood.

As the average crushing capacity of the Queensland mills may be taken as $1\frac{5}{10}$ tons per stamp per day, it will be seen that not one-half of the crushing capacity of the Queensland goldfields has been usefully employed during that year.

No doubt such a state of affairs is due partly to the unproductiveness of some of the mines, partly to the prevailing desire of each individual mining company to possess its own mill. It surely stands to reason that a smaller number of mills or a consolidation of several smaller mills into a larger plant under one roof would have the tendency not alone of lowering the cost of milling per ton of ore, but also of allowing the introduction of auxiliary appliances as rock-breakers, automatic feeders, and vanners, the adopting of which very often is not within the means of a smaller concern.

In further perusal of the Annual Report of the Under Secretary for Mines, we find that the Queensland goldfields are credited with 756 Berdan pans, 222 Wheeler pans, 42 Dvenny and other pans, against the following concentrating machinery:—134 Brown and Stanfield's concentrators, 36 percussion and shaking tables, and 76 vanners.

It may safely be asserted that the results of the extraction would be greatly enhanced if the greater portion of the grinding machinery were to be replaced by suitable concentrating appliances.

The Burdekin mill at Charters Towers had some twenty vanners, but for some reason, not quite clear to the writer, they were discarded, although the stone which is being crushed there carries a fair percentage of sulphurets, which are well worth saving by a clean concentration. This certainly must appear as a retrograde step in the face of modern practices and experience elsewhere.

Nothwithstanding that the Queensland mills are crushing annually some 400,000 tons of quartz, which may be estimated to yield at least 2½ per cent. mineral contents, the production of "clean" concentrates, not carrying more than 5 to 20 per cent. sand, falls much below 1,000 tons per year.

The only really clean pyritic concentrates which the writer has ever seen in Queensland came from the Mount Rose and Stockman Junction mill, and from the River mill, at Eidsvold. Ravenswood has also contributed to the production of clean concentrates, which in all three cases were vanner-concentrations. By ordinary hand-washing operations fairly clean pyrites are being obtained in Gympie. The pyrites are very rarely rich on this field, but, with the present facilities of realising on pyritic ores, it must remain a matter of surprise that the crude hand-washing manipulation could not be superseded by something better.

C.—TAILINGS, EITHER AS SUCH OR ROUGHLY CONCENTRATED WITH UP TO 40 PER CENT. MINERAL.

The greater bulk of pyritic concentrates and slimes which are being treated at present by the various metallurgical works of the colony belongs to this class, and consists either of roughly concentrated tailings or the slimes from the grinding pans. Every goldfield in Queensland contributes its share to this material, which in its mineral composition may vary again between a simple pyritic form and the more or less complex sulphides of the base metals.

Its assay value may vary from 0·3 to 5 oz. per ton. Tailings or rough concentrates from Charters Towers with 72 to 74 per cent. of sand are known to have assayed from 4 to 5 oz. of gold per ton.

The writer will only mention here a special case, in which the material, owing to its peculiar mineral compounds, has been more thoroughly investigated.

A few years ago the Mount Shamrock Company (Gayndah district) erected a complete barrel chlorination plant, in order to deal with a large heap of concentrates assaying over 4 oz. of gold per ton.

Unfortunately, as in many cases of this kind, no attempt had been made to ascertain if the material would be suitable for chlorination, although it must be said, in justice to the management, that a casual observer, even if an expert, would not have noticed by the mere appearance of the rather sandy material that it contained anything detrimental to the extraction of gold by chlorine. The plant was in charge of an experienced metallurgist, who simply carried out the instruction of the management to chlorinate the "stuff." The results were somewhat disastrous, as it was found that more than 80 per cent. of the gold remained in the tailings. At that juncture the professional advice of the writer was requested, and the concentrates submitted to a complete quantitative analysis, with the following results:—

SiO_2	44·90	
Al_2O_3	8·82	
Fe	18·98	partly combined with S and As, partly oxidised.
S	11·71	
As	2·07	
CaO	2·80	Gold assay per ton, 4·35 oz.
MgO	1·05	
Te	0·56	
Bi	1·26	
$CO_2 + O + H_2O + Au$	7·85	found by difference.
	100·00	

As the management was naturally anxious to adapt the ore to the existing plant, which had cost over £3,000, an average sample, as represented by the above analysis, was subjected to a number of laboratory tests with the main object of finding some means for a better extraction by chlorination.

Test I.—A sample of 4 oz., after roasting in the muffle at a dull red heat and chlorinating, only helped to confirm the failure of the extraction as experienced on the larger scale.

Test II.—The material was ground to pass an 80-mesh sieve, and roasted with the addition of 5 per cent. of salt. The chlorination yielded $53\frac{1}{10}$ per cent. of the total gold contents.

Test III.—The same material roasted with the addition of 10 per cent. salt gave by chlorination an extraction of $78\frac{1}{10}$ per cent.

Test IV.—The original concentrates without further grinding were roasted with the addition of 15 per cent. salt. Loss of gold in roasting was $6\frac{3}{10}$ per cent. Total extraction of gold by chlorination, 72 per cent.

Test V.—The finely-ground material (80-mesh) roasted with 15 per cent. salt, which was gradually added, showed a loss of gold in roasting of 3 per cent., while chlorination extracted 87 per cent. of the original gold contents.

Test VI.—Dilute cyanide solutions of various strengths gave indifferent results.

The above tests were made in duplicates, and from the results obtained in Test V. it may be safely concluded that a still higher addition of salt would have brought about a somewhat higher percentage of extraction. However, as the regrinding of the material to such a fine mesh, together with the additional cost of, say, at least 15 per cent. of salt, formed two very important economic considerations, the company finally decided to sell the concentrates to smelting works, which were able to guarantee better returns than could possibly have been obtained at the mine.

The greater part of the gold undoubtedly existed in these concentrates, as telluride of gold, in conjunction with bismuth telluride, and sulphide.

Under the present system of gold-milling, the writer estimates that over 20,000 tons of silicious concentrates and slimes should be available for further treatment every year, exclusive of old tailing heaps.

D.—COMPARATIVELY RICH ORES WITHOUT OR WITH VERY LITTLE SULPHURETS.

This class is mainly represented by the Mount Morgan ore, the character of which is so sufficiently known now as not to require a further description.

E.—ARGENTIFEROUS GOLD ORES AND EXCEPTIONAL ORES.

Some of the Croydon gold ores are distinctly argentiferous in character. A parcel of 10 tons, which was submitted to the writer, assayed 51 oz. silver to 2·4 oz. gold per ton; it was a "dry" ore with 95 per cent. of SiO_2.

A number of shallow workings at Boolboonda used to produce a semi-oxidised argentiferous and auriferous copper pyrite, of which the following assays are representative examples:—

	No. 1.	No. 2.
Cu.	15·4	13·8
Au.	0·85 oz.	1·2 oz.
Ag.	37 ,,	20 ,,

Quite recently a parcel of about one ton, consisting of an apparently crushed and washed quartz from Mount Morinish (Rockhampton), was submitted for treatment. Upon being assayed it gave 10·5 oz. of gold, also 2·8 per cent. of copper.

A further investigation showed the copper to be present as very fine and laminated particles of native copper, which was found to be alloyed with the greater portion of the gold.

The stone used to be reduced at a local crushing-mill, but, to the great disgust of the owners of the mine, after cleaning up and retorting, the results, though very bulky, only consisted of auriferous metallic copper. A number of these retort residues have passed through the hands of the writer, and, although varying in richness, very rarely carried more than 2·5 per cent. of gold.

Efforts are being made at present to find a rational method for the treatment of this stone.

THE TREATMENT OF REFRACTORY GOLD ORES IN QUEENSLAND.

It has often been said that Queensland offers a large field to the inventor of *new processes* for the extraction of gold.

As already pointed out in the previous paragraphs, the Queensland milling methods may be improved upon; but the writer would rather prefer to see these improvements brought about on lines of well-established metallurgical practices. At present Queensland is well provided with metallurgical works, which are fully able to deal with the refractory gold ores of the colony, so as to leave very little room for improvement in that respect.

We find large chlorination works at Mount Morgan, also on a smaller scale at Charters Towers and Ravenswood; there are general smelting works at Aldershot, which are dealing with a large quantity of auriferous material; and, finally, we have the cyanide process with well-established works at Charters Towers, Croydon, and Georgetown.

Each of these three metallurgical methods has its special sphere of usefulness, and no doubt in time their beneficial influence will be felt in every Queensland mining centre.

CHLORINATION.

A few years ago "barrel" chlorination was the usual application of this process in Queensland, with the exception of the Charters Towers pyrites works, which have always used the chlorine vats. Economic considerations, apparently, are responsible for the return to vats, which, however, are being erected of a much larger size than heretofore. At Mount Morgan vats holding about 25 tons of charge have replaced the barrels and smaller vats. The chlorine is being applied there now as chlorine water, for which it is claimed that the consumption of the solvent can be better controlled and kept within the absolute requirements for the extraction of the gold.

The use of chloride of lime and sulphuric acid has been superseded again by manganese, salt and sulphuric acid, and the installation of chlorine stills, towers, and solution tanks.

The official report of the Mount Morgan Company, Limited, for the year ended 31st May, 1894, places the extraction within a small fraction of 95 per cent. of the assay value of the ore; and as 65,076 tons, assaying 1·66 oz. of gold per ton, have been treated during the year, the metallurgical results must be considered highly satisfactory.

The percentage of extraction of the smaller works could not be ascertained, but it may be safely assumed that equally good results are being obtained by them, varying, however, with the adaptability of the material under treatment.

The actual cost of chlorination at Mount Morgan, including milling and calcining, is about 15s. per ton; but it is expected that, with the introduction of a larger number of revolving furnaces and other facilities for the automatic handling of the material, the cost will be brought down to 12s. per ton. The cost at the smaller works may be put down as varying between 15s. and 25s. per ton. It must be mentioned here that these figures compare favourably with the cost of chlorination carried on under similar conditions elsewhere.

Public chlorination works generally guarantee 90 per cent. of the gold contents at £4 per ounce, less £2 to £3 per ton for treatment, unless special arrangements have been made for a different settlement.

SMELTING.

At Aldershot the auriferous pyrites, complex ores, &c., are being made up in suitable mixtures for calcining; and the slagged material is afterwards smelted with roasted mattes, oxidised lead ores, and limestone in a large blast furnace to a rich auriferous silver lead, which is partly refined at the works, partly sent to England.

The extraction is a very high one, as the works guarantee to pay from 90 to 97 per cent. of the assay value at £4 per ounce, less £2 to £3 per ton treatment charge. Special rebates are being allowed for an excess of iron in pyrites, which thus assist in reducing the cost of treatment per ton.

CYANIDING.

Although there can be no doubt that this process will have a future before it in Queensland, its adaptability, especially in such places where it has to compete with chlorination and smelting works, for high-grade concentrates and slimes must necessarily be confined to the treatment of tailings.

Its work on the "Rand" deserves certainly to be called a metallurgical achievement, but it must not be overlooked that almost up to date the "Rand" tailings consisted of a free milling material which was thoroughly suited to the extraction by cyanogen.

In Queensland, where we have to deal mainly with pyritiferous ores very often of a complex character, the conditions are somewhat altered. Nevertheless, there will always remain sufficient scope for the many admirable points of this process to extend its usefulness in Queensland.

The general requirements for a successful and economical operation of the process may shortly be stated as follows:—

First.—A fine division of the gold in the material.

Second.—Low-grade material, free of galenite, zincblende, and copper minerals, though it has been claimed that the presence of small quantities of the latter does not seriously interfere with the cyaniding.

Third.—The neutralising of acid material containing ferrous and ferric sulphates and basic sulphates, with lime or alkalies before cyaniding.

Fourth.—The material must possess good leaching properties, in order to facilitate percolation; but experience and an intelligent handling of the slimy material may, in some cases, overcome the obstacles generally encountered in the percolation of slimes.

The average extraction from 5 to 10 dwt. stuff may be taken as 70 per cent. to 80 per cent.; while, under favourable conditions, concentrates assaying from 3 to 4 oz. per ton may give an extraction of 90 per cent. to 95 per cent. in three or four weeks' treatment.

According to W. B. Feldtmann, in the *American Engineering and Mining Journal*, only very weak solutions are being used in the presence of any metals having an affinity for cyanogen.

The strength of the first solution may vary from 0·25 to 0·50, while the number and strength of subsequent solutions and washes, and the time of contact required, depend entirely on the quantity and nature of the ore.

Unfortunately, the exact figures on the cost of cyaniding in the Queensland works could not be ascertained, but the writer is probably not far wrong by putting the average cost at from 7s. 6d. to 10s. per ton.

Thanks to the courtesy of the respective managements, I am able to submit the following figures, showing the total output of gold of the three principal public metallurgical works of the colony:—

The Charters Towers Pyrites Company (chlorination), 20,122 oz. standard gold.

The Australian Gold Recovery Company, Charters Towers (McArthur-Forrest process), 14,533 oz. standard gold.

The Queensland Smelting Company, Limited, Aldershot, 36,870 oz. fine gold.

7.—ANALYSES OF THE ARTESIAN WATERS OF NEW SOUTH WALES, AND THEIR VALUE FOR IRRIGATION AND OTHER PURPOSES.

By JOHN C. H. MINGAYE, F.C.S., M.A.I.M.E., Analyst to the Department of Mines, N.S.W.

(No. 2.)

In a previous paper read before the *Royal Society of New South Wales, treating on some of the well, spring, mineral, and artesian waters, some fifty-three analyses were given, and a large amount of information *re* value for irrigation, &c. Since this paper was published, analyses have been made of a number of waters obtained from the artesian bores in the western district, and, by permission of the Honourable the Minister for Mines and Agriculture, I have much pleasure in placing the results obtained before this Society.

The paper comprises some twenty-one analyses, and in every case where possible a complete analysis has been furnished. The results are expressed in grains per imperial gallon; also calculated into parts per 1,000 for comparison with other analyses published in England, America, India, and elsewhere.

The value of a water for irrigation purposes depends largely on the nutrient matters in solution, and the absence of large quantities of injurious salts. The ingredients valuable for this purpose are the nitrogen, potash, phosphoric acid, and lime. The presence of large amounts of alkaline salts, especially carbonate of soda, are very detrimental to plant life, and act on the soil and injure all useful vegetation by their corrosive action, chiefly upon the root-crowns and upper roots of plants. The neutral salts—*i.e.*, chloride of sodium (common salt), sulphate of soda (Glauber's salt), sulphate of magnesia (Epsom's salt), and others—are injurious in a lesser degree, and only when they occur in large quantities can relief be obtained by washing them out of the soil by under drainage, &c. It will be noticed on comparing the analyses of these waters that the total solid matter, excepting in five of the samples, is small, the main constituents present being carbonate of soda, chloride of sodium, carbonate of potash, with lesser amounts of carbonates of lime, carbonate of magnesia, alumina,

* Jour. Roy. Soc. N.S. Wales, vol. xxvi., 1892, p. 73.

silica, organic matter, &c. A most important constituent in these waters is the rather large proportion of potash present, thus contributing this important fertiliser to the soil irrigated with artesian waters.

The composition of the soils in the neighbourhood of these bores is one of great interest. The great trouble contended against in parts of India and America on their irrigation works is that a large number of the soils already contain "reh," or alkaline salts.

Analyses made of the soluble salts, in two samples of soil taken from near the Barringun artesian bore, yielded as follows:—

	No. 1.	No. 2.
Soluble saline matter	1·0328%	·9416%
Consisting of—		
Soda (Na_2O)	0·2950	0·2131
Potash (K_2O)	·0439	·0934
Lime (CaO)	·0628	·0748
Magnesia (MgO) ...	·0279	·0229
Clayey matter	·0168	·0172
Sulphuric anhydride (SO_3)	·1130	·0910
Chlorine (Cl)	·4340	·3830
Carbonic acid (Co_2) and organic matter	·0394	·0462
	1·0328	·9416

The soils gave a very slight alkaline reaction.

Mr. F. B. Guthrie, F.C.S., Analyst to the Department of Agriculture, has kindly furnished me with the analysis of a mixture of seven soils obtained from the neighbourhood of the Native Dog Bore. The soils had been cropped.

Reaction—Slightly Alkaline.

Capacity for water	26·33
Absorbed weight per acre (6 inches deep)	3,567,293

Mechanical Analysis.

Root fibres	None
Stones	None
Coarse gravel	·08
Fine gravel	7·00
Sand	84·54
Clay	8·38
	100·00

Fine Soil.

Moisture... ... ... 1·783%

Volatile and combustible matter 3·138% } = Nitrogen ·089% (fair) = Ammonia ·108%

Soluble in hydrochloric acid sp. gr. 1·100

Lime (CaO)	·085 (fair)
Potash (KO) (K_2O)	·249 (satisfactory)
Phosphoric acid (P_2O_5)... ...	·079 (fair)

A large amount of valuable work has been performed in India and America with regard to the use of artesian waters for irrigation purposes, where in places great difficulty has occurred as to the rise of "reh" in the soils. Our soils in the western districts, where these artesian bores are situated, being of a sandy nature and good depth, a water containing a fair amount of saline matter could be used for irrigation, where the same water if applied to another class of soil for some years, especially if a system of drainage was not properly carried out, and occasionally the soluble salts worked out, would cause the soil to become saturated, and in time kill all useful vegetation. It has been found in America that the carbonate of soda is the worst form of salt that has to be contended against in the use of these saline waters for irrigation purposes. It renders the soil caustic and corrosive, and dissolves the humus, which is shown by the dark colour of the water standing on alkali spots, and the black rings left when such water evaporates. By the use of gypsum (calcium sulphate) in small quantities its corrosive action can be remedied to a great extent. A chemical action takes place, the gypsum in contact with the carbonate of soda forming carbonate of lime and sulphate of soda (Glauber's salt). The first is beneficial to the soil, and the latter is a neutral salt, which, according to Professor E. W. Hilgard, is from ten to twenty times less injurious than the carbonate of soda. In America, in districts affected with the carbonate of soda in the soil, it has been found in numerous cases that the simple use of gypsum, conjointly with summer tillage to keep the soil loose, has sufficed to enable land that never before produced anything of value to bear abundant crops. By the aid of deep tillage and rotation of crops it is often possible to absorb a large amount of these soluble salts or "reh" in the plants. Beets, carrots, and many other root crops are known to absorb a large amount of soluble salts. (*Vide* Reports of Examinations of Water and Water Supply, by Professor E. W. Hilgard, Agricultural Experimental Station, University of California.)

As already pointed out, many of the soils in the districts where irrigation has been carried on in America and India contain already a fair proportion of "reh"—*i.e.*, highly soluble saline matter.

In a report* furnished by the Government of India, by E. E. Oliver, Esq., Department of Punjab, it is pointed out that "reh" is rarely developed in sandy soils. Mr. Ibbertson, another Indian authority on irrigation, says: "Within his knowledge it never appears in sand. It is seldom very apparent in stiff clayey soils; but loam is affected to an enormous extent."

In India, the antidote used for land affected with "reh" is nitrate of lime; this salt was recommended by Dr. Brown, late Chemical Examiner to the Punjab District, who showed that, mixed with the injurious salts of "reh," decomposition occurs, and nitrate of soda with the sulphates and carbonates of lime are produced; these salts being directly beneficial to vegetation, the nitrate of soda supplying the plants with the nitrogen they so much need, and sulphate of lime absorbing ammonia from the air.

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* Report on Reh, Swamp, and Drainage of the Western Jumna Canal Districts, 1881. Lahore Public Works Dept. Press.

We have now a number of artesian bores in the arid western district which yield water suitable for human consumption and stock purposes, and sufficient surplus water for the irrigation of small holdings or farms, orchards, &c. The presence of these artesian supplies are of the greatest value to travelling stock, they having been the means of keeping thousands alive which in time of drought would have perished for want of water.

In a report received by Mr. F. G. Pickering from his manager, that gentleman refers to the water obtained from the 121-mile Bore, as follows:—"The quality is excellent, in fact could not be better. It is very hot when first pumped up, registering 115 degrees Fahr., but soon cools, and its value to the residents of the locality, travelling stock, teams, and the general public cannot be estimated, as not a drop is otherwise obtainable for many miles. The country there is in a deplorable state—no water and no grass—no rain having fallen since September last, while the heat registered up to 119 degrees Fahr. in the shade. Provisions were selling as follows:—Flour, 60s. per 200-lb. sack; potatoes, 28s. per cwt.; vegetables, when obtainable, 4d. per lb.; sugar, 6d. per lb.; tea, 4s. per lb. At one particular station the proprietor is paying £14 per ton for the carriage of horse and cattle feed, the distance of transit being 105 miles. As much as £1 is paid for a single bag of chaff, and that of an inferior quality. At one station alone over 40,000 sheep perished for want of water." (*Evening News*, 17th May, 1892.)

With a view of ascertaining the suitability of some of the artesian bore waters for irrigation purposes, the Superintendent of Public Watering Places suggested that experimental farms should be started in the vicinity of some of these bores, and experiments conducted for some years in the raising of various classes of cereals, vegetables, fruit, and forest trees. These suggestions were acted on by the Honourable the Minister for Mines and Agriculture, and the results obtained in most cases, so far, have been very satisfactory.

At the Native Dog Bore, situated on the Bourke-Barringun road, an experimental farm, embracing four acres of land, has been made, thus utilising the supply in excess of that required for travelling stock. Mr. Boultree, in reporting on this bore, states—"The water from this bore is carried by a ditch into a considerable depression, forming a small lake covering fully two acres of land, which acts as an aerating pool. The whole is enclosed with a good post-and-wire fence securely rabbit-netted." The farm at this bore was laid out by Mr. Inspector Macdougall, in October, 1892, and the first planting done during that month. The seeds planted were lucerne, millet, maize, sorghum, and planters. The lucerne did not grow well until the following March or April, the planters and sorghum being cut in January, 1893. Some small samples of wheat were sown on 16th June, 1893, gathered on the 17th November, 1893, and which had been three times watered. The yield was over 35 bushels per acre.

In July, 1893, the farm was enlarged, and some trees and vines planted, and those living and doing well are—456 fruit trees, 70 olives, 480 vines, a few bananas; also 2,000 forest trees and

23 sugar-canes. The average waterings were once every three weeks, until the warm weather came on, and after that sometimes once a week. Pumpkins, melons, &c., were sown on the 9th September, and were ripe on 26th November. A trial farm was also laid out on the Barringun Bore in October, 1892. The seeds planted were lucerne, millet, maize, sorghum, and planters. The maize did not do very well; but the others thrived well. The lucerne has been cut on an everage every three months since. Trees and vines were planted, and mostly all the fruit trees are doing well; as also is the sugar-cane. The plants are irrigated about once every three weeks. At this bore 100 acres are under irrigation, raising fodder for the working horses, and in a bad season, the Superintendent of Public Watering Places states, from his personal knowledge, that £1,500 was spent in one season upon a property in the district for horse feed alone.

At the Belalie Bore an experimental farm was planted with 747 forest trees, 128 fruit trees, and 484 grape cuttings. Those living and doing well are over 400 forest trees, 100 fruit trees, and 160 vines. The forest and fruit trees were watered almost daily in September and October, but only sparingly, as the caretaker carried the water in buckets, and gave each plant one pint. After the month of October the trees were watered once a month. The trees planted on this farm are looking better than any on the other farms.

The mortality in a large number of cases may be attributed to the difficulty in forwarding the trees, and the long land carriage necessary to land them on the spot. Some of the plants—oranges especially—were described as perished before being planted.

On an experimental farm laid out at the Enngonia Bore near Bourke, in July, 1893, there are thriving over 500 forest trees, 100 fruit trees, and 80 vines. These were watered once every two or three weeks.

The quantity of water obtained through our bores must necessarily be limited, and cannot be available for the irrigation and reclamation of vast areas of land; but there is a large quantity over and above that required for human consumption and stock, which can be utilised for the irrigation of small farms and orchards, and thus reclaim land which previously was barren. In the southern part of California, Texas, and other districts these waters are being widely used for the irrigation of small farms, orchards, &c. At the celebrated fruit ranch of Riverside, San Bernardino Co., California, which derives a portion of its water supply from artesian wells, there are over 12,000 acres of fruit trees under cultivation, served by thirty-eight artesian wells.

At San Gabriel, California, 1,200 acres in extent are supplied solely by artesian wells, of which there are twenty-one on the estate, varying from 75 to 100 feet deep. The Alamosa Town Well, situated in the San Luis Valley, is described as the principal source of 30 miles of irrigation ditches within the corporate limits of Alamosa. In Hawaii, in the margin of Pearl Harbour, 20,000 acres of rice and large areas of bananas are irrigated by artesian wells, in addition to which power is provided for several large mills.

On comparing the analyses of these waters, it will be observed that they yield total solids varying from 33· to 396· grains per imperial gallon.

Waters yielding such large proportions of saline matter as contained in the waters of the Opera, Barrona, Tinchelooka, and Cuttaburra Bores are useless for irrigation, their continual use tending to kill all useful vegetation.

The waters from the Sibraas, Moongulla, and Dungle Ridge Bores contain rather a large amount of saline matter in their composition; but with careful use, deep drainage, and the occasional addition of gypsum to the soil they possibly could be used with no ill effects.

Waters such as obtained from the Kelly's Camp, Yantabulla, Enngonia, Belalie, Kerribree Creek, Barringun, Corrella Nos. 1, 2, and 3, Waroo Springs, Native Dog, and Youngerrina Bores—although containing carbonate of soda in their composition, the total solid matter present being small—may be used for irrigation, every care being exercised, if found necessary, to neutralise the corrosive action of the alkali. A thorough system of deep drainage is required, and rotation of crops, as it is well known that *beets, &c., absorb a large amount of soluble salts. It has been stated that the artesian waters are unsuitable for wool-scouring; but the majority of them are, without doubt, eminently suited for that purpose, from the alkaline carbonates present, which renders the waters "soft." Mr. J. B. Christians, of Brendingabba Station, Hungerford road, informs me that he has used these waters, and obtained excellent results from them; 1,000 bales, washed by artesian waters, averaged 1s. 3½d. per lb. These waters, I am informed, are also used in parts of Queensland for that purpose by Messrs. Collings, White, and Co., Eulolo Station, near Rockhampton.

ANALYSES OF WATERS FROM ARTESIAN BORES, NEW SOUTH WALES.

ANALYSIS OF WATER FROM OPERA (25-MILE) BORE.

Bore 791.—Sub-artesian, water running to within 18 feet of the surface; estimated at 10,000 gallons per diem; on the Louth-Wanaaring road, near Bourke.

	Grains per gallon.	In 1,000 parts.
Silica	·996	0·0142
Sodium chloride	278·382	3·9769
Potassium chloride	12·274	·1753
Calcium chloride	5·838	·0834
Magnesium chloride	6·580	·1169
Calcium carbonate	8·190	·0940
Sulphuric anhydride	Trace	Trace
Organic matter	Trace	Trace
Total solid matter	312·260	4·4607

A strong saline water unsuitable for human consumption, and useless for irrigation.

* Reports of Examinations of Waters, &c., by Prof. Hilgard, College of Agriculture, California.

ANALYSIS OF WATER FROM BARRONA (46-MILE) BORE.

Artesian supply struck at 1,010 feet from the 46-Mile Bore; estimated at 200,000 gallons per diem; temperature, 100° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	1·204	0·0172
Sodium chloride	78·173	1·1167
Potassium chloride	52·508	·7501
Sodium carbonate	7·952	·1136
Calcium carbonate	7·550	·1078
Magnesium carbonate	·987	·0141
Organic matter	Trace	Trace
Total solid matter	148·374	2·1195

ANALYSIS OF WATER FROM TINCHELOOKA (75-MILE) BORE.

Bourke to Wanaaring road, seven miles distant from previous sample; supply estimated at 70,000 gallons per diem; depth, 1,234 feet; temperature, 92° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	1·372	·0196
Sodium chloride	66·074	·9439
Potassium chloride	50·816	·7259
Sodium carbonate	3·526	·0503
Calcium carbonate	6·650	·0950
Magnesium carbonate	1·510	·0215
Organic matter	Trace	Trace
Total solid matter	129·948	1·8562

ANALYSIS OF WATER FROM SIBRAAS BORE.

Depth, 1,057 feet; flow per diem, 500,000 gallons.

	Grains per gallon.	In 1,000 parts.
Silica	2·240	·0320
Sodium chloride	30·321	·4331
Sodium carbonate	24·951	·3564
Potassium carbonate	8·289	·1184
Calcium carbonate	2·799	·0399
Magnesium carbonate	Trace	Trace
Alumina and ferric oxide	·308	·0172
Organic matter	1·204	·0044
Total solid matter	70·112	1·0014
Free ammonia	·010 per 100,000 parts	
Albuminoid ammonia	·012 do.	
Nitrogen as nitrates	Trace	
Phosphoric acid as phosphates	Minute trace do.	

ANALYSIS OF WATER FROM KELLY'S CAMP BORE.

Depth, 1,577 feet; flow per diem, 600,000 gallons; temperature, 112° Fah.

	Grains per gallon.	In 1,000 par
Silica	1·316 ...	·0188
Sodium chloride	7 909 ...	·1129
Sodium carbonate	16·869 ...	·2409
Potassium carbonate	5·666 ...	·0809
Calcium carbonate	·689 ...	·0098
Magnesium carbonate	Trace ...	Trace
Alumina and trace of ferric oxide	·196 ...	·0028
Organic matter	2·436 ...	·0348
Total solid matter	35·081 ...	0·5009
Free ammonia	·016 per 100,000 parts	
Albuminoid ammonia	·024 do.	
Nitrogen as nitrates	Trace	
Phosphoric acid as phosphates ...	Minute trace do.	

ANALYSIS OF WATER FROM YANTABULLA BORE.

Depth, 209 feet; flow per diem, 28,000 gallons.

	Grains per gallon.	In 1,000 parts.
Silica	1·456 ...	·0208
Sodium chloride	9·557 ...	·1365
Sodium carbonate	17·369 ...	·2481
Potassium carbonate	6·615 ...	·0945
Calcium carbonate	1·549 ...	·0221
Magnesium carbonate	·930 ...	·0132
Alumina and ferric oxide ...	Trace ...	Trace
Organic matter	2·520 ...	·0360
Total solid matter	39·996 ...	0·5712
Free ammonia	·009 per 100,000 parts	
Albuminoid ammonia	·020 do.	
Nitrogen as nitrates	Trace	
Phosphoric acid as phosphates ...	Minute trace do.	

ANALYSIS OF WATER FROM ENNGONIA BORE.

Depth, 1,673 feet; flow, 320,000 gallons per diem; temperature, 117° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	1·694 ...	·0242
Sodium chloride	7·745 ...	·1106
Sodium carbonate	30·367 ...	·4338
Potassium carbonate	4·741 ...	·0677
Calcium carbonate	1·199 ...	·0171
Magnesium carbonate	Nil ...	Nil
Alumina and ferric oxide	Trace ...	Trace
Organic matter	1·904 ...	·0272
Total solid matter	47·650 ...	·6806
Free ammonia	·071 per 100,000 parts	
Albuminoid ammonia	·008 do.	do.
Nitrogen as nitrates	A minute trace	do.
Phosphoric acid as phosphates ...	do.	do.

ANALYSIS OF WATER FROM BELALIE GOVERNMENT BORE.

Depth, 1,580 feet; flow per diem, 500,000 gallons; temperature, 117° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	1·260	·0180
Sodium chloride	7·909	·1129
Sodium carbonate	27·773	·3967
Potassium carbonate	1·269	·0181
Calcium carbonate	·649	·0092
Magnesium carbonate	Trace	Trace
Alumina and ferric oxide	Trace	Trace
Organic matter	·924	·0132
Total solid matter	39·784	·5681

Free ammonia	Nil	per 100,000	parts
Albuminoid ammonia	·002	do.	do.
Nitrogen as nitrates	Trace	do.	do.
Phosphoric acid as phosphates	Minute trace	do.	

ANALYSIS OF WATER FROM KERRIBREE CREEK BORE.

Depth, 1,193 feet; flow, 800,000 gallons per diem; temperature, 108° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	·980	·0140
Sodium chloride	7·745	·1106
Sodium carbonate	17 596	·2515
Potassium carbonate	6·377	·0911
Calcium carbonate	·619	·0092
Magnesium carbonate	Nil	Nil
Alumina and ferric oxide	Trace	Trace
Organic matter	1·008	·0144
Total solid matter	34·355	·4908

Free ammonia	Trace	per 100,000	parts
Albuminoid ammonia	·002	do.	do.
Nitrogen as nitrates	Nil	do.	do.
Phosphoric acid as phosphates	Minute trace		do.

ANALYSIS OF WATER FROM BARRINGUN BORE.

Depth, 1,711 feet; flow per diem, about 170,000 gallons; temperature, 115° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	1·736	·0248
Sodium chloride	6·739	·0962
Sodium carbonate	23·932	·3418
Potassium carbonate	6·104	·0872
Calcium carbonate	·350	·0050
Magnesium carbonate	Nil	Nil
Alumina and trace of ferric oxide	·252	·0036
Organic matter	Trace	Trace
Nitrates and phosphoric acid	Trace	Trace
Total solid matter	39·113	·5586

ANALYSIS OF WATER FROM CORRELLA NO. 1 BORE (PRIVATE).

Depth, 900 feet; temperature, 96° Fah.

	Grains per gallon.	In 1,000 parts.
Silica	1·288 ...	·0184
Carbonate of lime	1·000 ...	·0142
Carbonate of magnesia	·336 ...	·0047
Alumina	Trace ...	Trace
Sulphate of potash	Nil ...	Nil
Chloride of sodium	8·733 ...	·1146
Carbonate of potash...	7·170 ...	·1024
Carbonate of soda	27·813 ...	·3973
Organic matter	Trace ...	Trace
Total solid matter	46·340 ...	·6516

ANALYSIS OF WATER FROM CORRELLA NO. 2 BORE (PRIVATE).

Depth, about 960 feet; temperature, 92° Fah.

	Grains per gallon.	In 1,000 parts.
Total solid matter (dried at 220° F.)	50·316 ...	·7188
Soluble saline matter	48·104 ...	·6872
Insoluble mineral matter	2·212 ...	·0316
	50·316 ...	·7188
Chlorine in combination	6·80 ...	·0971
Sulphuric anhydride in combination	Nil.	

The soluble matter (saline) consists mainly of carbonates of soda, carbonate of potash, chloride of sodium, &c.; the "insoluble" of carbonate of lime, silica, trace of carbonate of magnesia, alumina, &c.

ANALYSIS OF WATER FROM CORRELLA NO. 3 BORE (PRIVATE).

Depth, about 960 feet; temperature, 102° Fah.; total solid matter (dried at 220° Fah.), 56·868 grains per gallon.

	Grains per gallon.
Soluble saline matter	45·584
Insoluble mineral matter	11·284
Total solid matter	56·868
Chlorine in combination	4·70
Sulphuric anhydride in combination...	Nil

The soluble saline matter consists mainly of carbonates of soda and potash, chloride of sodium, &c.; the "insoluble" of carbonates of lime and magnesia, silica, trace of alumina, &c.

Both waters, on evaporation, gave a strong alkaline reaction. The compositions of these waters are almost identical with the analyses of that taken from the No. 1 Corrella Bore (private); also two samples from two artesian bores at Bourke. The samples received were too small for a more detailed analysis.

ANALYSIS OF WATER FROM WAROO SPRINGS BORE.

	Grains per gallon.	In 1,000 parts.
Silica	1·288	·0184
Sodium chloride	8·404	·1200
Sodium carbonate	19·211	·2744
Potassium carbonate	4·558	·0651
Calcium carbonate	·599	·0085
Magnesium carbonate	·614	·0087
Alumina and trace of ferric oxide	·252	·0036
Organic matter	·868	·0124
Total solid matter	35·794	·5111

Free ammonia	·012 per 100,000 parts	
Albuminoid ammonia	·005 do.	do.
Nitrogen as nitrates	Minute trace	do.
Phosphoric acid as phosphates	do.	do.

ANALYSIS OF WATER FROM CUTTABURRA BORE.

Depth, 1723 feet; flow per diem, about 20,000 gallons.

	Grains per gallon.	In 1,000 parts.
Sodium chloride	349·040	4·9863
Potassium chloride	Trace	Trace
Calcium chloride	27·580	·3940
Magnesium chloride	4·190	·0598
Ammonium chloride	·642	·0092
Calcium carbonate	6 664	·0952
Magnesium carbonate	·336	·0048
Silica	1·596	·0238
Alumina	Trace	Trace
Protoxide of iron	·112	·0016
Alkaline carbonates, organic matter, strong trace of bromide, traces of iodine, nitrates, &c.	6·712	·0959
	396·872	5·6706

Remarks.—Water clear and free from matter in suspension. To the taste strongly saline. Not suitable for domestic purposes, and useless for irrigation.

ANALYSIS OF WATER FROM MOONGULLA BORE.

Depth, 2,570 feet; flow per diem, about 1,750,000 gallons; temperature, 150° Fah.

The water, on evaporation, yielded 83·972 grains per gallon of total solid matter (dried at 220° Fah.), which, on analysis, yielded as follows:—

	Grains per gallon.	In 1,000 parts.
Chloride of sodium	19·939	0·2848
Carbonate of soda	54·795	·7828
Carbonate of potash	5·457	·0779
Carbonate of lime	·800	·0114
Carbonate of magnesia	Nil	Nil
Silica and silicates	2·072	·0296
Nitrates	Trace	Trace
Total solid matter	83·063	1·1865

Remarks.—The water gave an alkaline reaction to litmus paper, due to the carbonated alkali present. Contains a very small amount of suspended matter, which consists almost entirely of carbonate of lime. No poisonous metals detected.

This water contains more carbonate of soda than hitherto found in the waters examined from this district. I am of opinion, however, that with careful use and deep drainage this water is suitable for irrigation purposes.

ANALYSIS OF WATER FROM DUNGLE RIDGE BORE.

Depth, 2,566 feet; flow per diem, about 850,000 gallons; temperature, 122° Fah.; total solid matter (dried at 220° Fah.), 77·140 grains per gallon.

	Grains per gallon.	In 1,000 parts.
Silica and silicates	1·652 ...	0·0236
Oxide of iron (Fe_2O_3)	·252 ...	·0036
Alumina (Al_2O_3)	Trace ...	Trace
Soda (Na_2O)	40·639 ...	·5805
Potash (K_2O)	2·369 ...	·0338
Lime (CaO)	·214 ...	·0030
Magnesia (MgO)	1 268 ...	·0181
Carbonic acid (CO_2)	21·600 ...	·3085
Sulphuric acid (SO_3)	Trace ...	Trace
Chlorine (Cl)	9·400 ...	·1343
	77·394 ...	1·1054

Remarks.—The water had an alkaline reaction, due to the alkaline carbonates present. With careful use and proper drainage, I am of opinion that the water from this bore may be used for irrigation purposes.

ANALYSIS OF WATER FROM NATIVE DOG BORE.

Depth, 475 feet; temperature, 92° Fah.; flow per diem, estimated at 500,000 gallons.

	Grains per gallon.	In 1,000 parts.
Total fixed matter	45·108 ...	·6440
Soluble saline matter	44·044 ...	·6292
Insoluble mineral matter	1·064 ...	·0152
Chlorine in combination	4·500 ...	·0642
Equal to chloride of sodium ...	7·415 ...	·1059

The soluble saline matter consists mainly of alkaline carbonates, chloride of sodium, sulphuric acid, &c.; the "insoluble," of silica and traces of carbonate of lime and magnesia. The water gave an alkaline reaction before and after evaporation. The quantity of water received in both samples (Native Dog and Youngerrina) was too small to enable a more detailed analysis being made; these waters may be used for irrigation purposes, and are suitable for all domestic purposes.

It will be observed that the saline matter consists mainly of carbonated alkalies, which are known when present in large quantities to exert a serious influence on plant life by their corrosive action on the young roots, &c. The action can, to a great extent, be remedied by the addition of a small quantity of gypsum to the soil prior to irrigation. The amount of alkaline carbonates present in these waters is much too small to condemn them for irrigation purposes.

ANALYSIS OF WATER FROM YOUNGERRINA BORE.

Depth, 168 feet; temperature, 82° Fah.; flow per diem, estimated at 120,000 gallons.

	Grains per gallon.	In 1,000 parts.
Total fixed matter	32·984 ...	·4712
Soluble saline matter	31·892 ...	·4556
Insoluble mineral matter	1·092 ...	·0156
Chlorine in combination	5·100 ...	·0728
Equal to chloride of sodium ...	8·404 ...	·1200

The soluble saline matter consists mainly of alkaline carbonates, chloride of sodium, sulphuric acid, &c. The insoluble matter almost entirely consists of silica, with traces of carbonates of lime and magnesia. Water clear, free from odour and matters in suspension. Before evaporation, and after, gave a strong alkaline reaction. Suitable for domestic uses, and stock and irrigation purposes.

References.—The author desires to express his indebtedness to the following:—

(1.) Hilgard, E. W., Prof. Reports of Examinations of Water and Water Supply; University of California.

(2.) Powell, J. W. Eleventh Annual Report for 1889-90; Part II., Irrigation; United States Geological Survey.

(3.) Lahore Public Works Department. Report on Reh, Swamp, and Drainage of the Western Jumna Canal Districts, 1881.

(4.) Boultbee, J. W., Officer in Charge of Water Conservation, for various Reports.

(5.) David, T. W., Prof. Artesian Waters in New South Wales; Royal Society of New South Wales, November 4, 1891.

8.—SOME NOTES ON THE POISONOUS CONSTITUENTS OF *STEPHANIA HERNANDIÆFOLIA.*

By E. H. RENNIE, M.A., D.Sc., and E. F. TURNER

Some time ago we published (Proc. Roy. Soc., S. Australia) a note in which we announced that we had separated and identified picrotoxin as one of the constituents of the abovenamed plant, but in which we also stated that, as suspected by Dr. T. L. Bancroft, there is one alkaloid at least present in addition. It would appear from subsequent correspondence with Dr. Bancroft that he thinks that scarcely sufficient prominence was given to the presence of this alkaloid in the note referred to. If so, the neglect on our part was quite unintentional. Since then we have endeavoured to isolate this alkaloid in larger quantity, and to examine it more thoroughly, but our efforts have been only partially successful. There is, however, undoubtedly a very poisonous alkaloid present, which, so far as we have been able to ascertain, has a yellowish colour, and gives a brilliant green colouration, which rapidly passes into brown when moistened with a drop or two of sulphuric acid. In one experiment a small quantity when injected produced in a frog gradual paralysis of the limbs, followed subsequently by violent convulsions and death. We wish it to be distinctly understood that the discovery of this alkaloid is due to Dr. Bancroft.

9.—PRELIMINARY NOTES ON THE BARK OF *CARISSA OVATA*, R. Br., VAR. *STOLONIFERA*, Bail.

By J. H. MAIDEN and H. G. SMITH.

Dr. T. L. Bancroft, of Brisbane, communicated a paper to the Royal Society of New South Wales, read 6th June, 1894, giving the results of his observations to that date on the bitter poisonous constituent contained in the bark of *Carissa ovata*, R. Br., var. *stolonifera*, belonging to the natural order Apocynaceæ. It will be unnecessary to quote the references and extracts given by him in reference to the poisons obtained from the plants belonging to this natural order, and used as arrow poison by the natives of Central America. The reader is referred to the above paper for this and other information.

Dr. Bancroft forwarded some of the bark to the Sydney Technological Museum for investigation and determination of the nature of this poisonous principle. It was with difficulty that the substance could be obtained sufficiently pure for investigation, and it was not until quite recently that we succeeded in obtaining it sufficiently pure for chemical research.

The process whereby the substance is obtained, by the use of acetate of lead, either neutral or basic, must be condemned in a general way, as it is impossible to obtain the glucoside undecomposed when sulphuretted hydrogen is used to remove the lead. When an aqueous solution of the bark is obtained and precipitated with neutral acetate of lead, some of the glucoside is removed with the colouring matters, tannic acid, &c., although the glucoside itself is not precipitated by the neutral lead salt. If to the filtrate from this precipitate basic acetate of lead is added, a yellowish precipitate forms, which is partly soluble in the liquid, as on adding more of the salt a further precipitate is obtained. This yellowish precipitate was decomposed with sulphuretted hydrogen, the lead removed, the filtrate evaporated to a honey consistence over the water bath at a low temperature, when a brownish mass was obtained; this readily reduced an alkaline copper solution in the cold, and was very impure. Another aqueous solution was obtained, evaporated down, and the mucilage removed by alcohol, and an aqueous solution from this was precipitated in fractions with basic acetate of lead until the filtrate ceased to give any marked reaction with ferric chloride solution. The filtrate was then treated with sulphuretted hydrogen to remove the lead in solution, filtered, and the filtrate evaporated to a pasty mass, which darkened greatly and was found to be greatly decomposed, readily reducing the copper solution in the cold. The method whereby Dr. Bancroft obtained his material was also tried, by precipitating the aqueous solution with acetate of lead, removing the lead by sulphuretted hydrogen, and evaporating to a honey consistence at a gentle heat on the water bath. The residue was very impure, showing that decomposition had readily taken place. It was thus seen that this method would have to be abandoned, as either the glucoside was decomposed by the sulphuretted hydrogen, or by the small amount of acetic acid set free, when the solution was evaporated to a stiff consistence; the residue having in all these cases a sugary smell. The method by which the best results were obtained, after many others had been tried, was by thoroughly extracting by hot water the finely ground bark, evaporating this to a small bulk, and adding rectified alcohol to precipitate mucilaginous substances, gum, &c. The filtrate was then evaporated down to a small quantity by distillation or on the water bath (low temperature on water bath being used in all cases), and water added. This forms a precipitate, and requires to be gently heated to remove all substances soluble in water. A small quantity of resinous bodies is thus removed. To this aqueous solution, which is dark, a very small quantity of basic acetate of lead is added. This removes the worst of the colouring matters and some of the tannic acid. The filtrate is then evaporated to perfect dryness with a large quantity of oxide of lead, and then the bitter glucoside is boiled out from this, with rectified alcohol. A solution is thus obtained free from tannic acid, mucilaginous substances, colouring matters, &c. The solution is almost colourless, the least trace of a primrose tint being seen. The alcohol thus obtained from the repeated boilings is evaporated to a honey consistence, when it is very slightly yellow, and consists largely of cauliflower-headed masses, which increase in quantity on standing. The substance thus obtained, when dissolved in water and filtered, does not reduce an alkaline copper solution in the cold but very slightly, and only slightly when raised to boiling point; but on continued boiling the glucoside is decomposed, when heated with a few drops of acid, and the copper solution when added is instantly reduced. When dried at a temperature of 90-95° Cent. in an air bath, at which temperature it dries hard, and allowed to remain in the air, moisture is taken up, and the varnish soon becomes quite moist; it is thus very deliquescent.

Five determinations were made for the detection of nitrogen in the substance obtained in various ways, but in no instance was it detected. Nitrogen is therefore absent, and consequently the active principle is not an alkaloid.

It is exceedingly bitter and persistent, causing nausea and headache. It is very poisonous. Six minims of an aqueous solution of the strength of about 10 or 15 per cent. (the exact strength was not ascertained), were injected under the skin on the shoulder of a half-grown kitten; the kitten was dead in ten minutes; it died without a struggle, slight twitchings being observable a few minutes longer.

The purified glucoside as thus obtained is totally insoluble in petroleum spirit, ether, and chloroform; slightly soluble in absolute alcohol in the cold, much more on boiling. This alcoholic extract dries as a varnish, but it takes up moisture and goes into the globular-headed masses.

Dilute alcohol dissolves it readily. It is not readily soluble in a small quantity of water in the cold at that stage, but readily dissolves in hot water; and if too much water has not been added, it again becomes turbid as it cools, and if then placed under the microscope it is readily seen how the globular cauliflower-headed masses form, as the turbidity is seen to be caused by little globules. These appear to congregate together in groups, and when further evaporated in the air they form together in little lumps of these globules, which do not break. There is no sign of crystallisation, nor were any signs of crystallisation seen by any method, although most carefully sought for with a ¼-inch objective. Several methods were tried, with all solvents —air dried, dried in vacuo, dried on the bath, all without result. When the alcoholic extract from the dried oxide of lead is evaporated to a small bulk and allowed to stand, water is absorbed, and these globular cauliflower masses form in a day or two. When spread on a piece of glass it is transparent, and remains so after some days, the only perceptible difference being the formation of the globular masses.

Although fairly pure, yet it was not sufficiently so for research work, and required to be further purified. One of two methods may be used. First, dissolve the thus purified substance in a small quantity of alcohol and precipitate with ether; allow to stand twenty-four hours, when the glucoside will have been precipitated as a thick mass at the bottom; pour off the ether and alcohol; wash with ether; dry in the air; dissolve in water; place in separator, and extract with amylic alcohol with continued portions of fresh extractive, well agitating the solutions; the amylic alcohol thus obtained is evaporated to dryness at a low heat over the water bath, when an amorphous substance is left which is but slightly deliquescent, slightly yellowish-brown, very bitter and of nasty taste; does not reduce an alkaline solution of copper in the cold, but slightly reduces it on raising to the boiling point, and instantly if inverted. This substance gives splendidly clear reactions, and may be considered as fairly pure. By this mode of proceeding there can be little besides this active principle present, all else having been removed by the previous processes. Secondly, if the roughly purified substance as obtained from the oxide of lead is dissolved in warm water, filtered, and, when cold, tannic acid added in excess, a precipitate forms, which after standing some time is removed, washed in water once or twice, and, while still moist, oxide of lead is added and then evaporated to dryness, the dried residue again being boiled out with alcohol. The second process might be considered the more accurate, as we might expect to obtain a purer product by precipitating it in this way; but there are several reasons why the first process is the better. First, the whole is not precipitated with tannic acid; secondly, a considerable portion is removed on washing; thirdly, as a final result the glucoside does not appear to be able to stand being boiled even with alcohol without partly decomposing; and, fourthly, the product is small in quantity, so that for future experiments we shall obtain the glucoside by the method of extraction from the aqueous solution of the roughly purified material precipitated by ether from alcohol.

When boiled in dilute acid, the liquid, if fairly dilute, remains clear while boiling, but becomes turbid on cooling; the decomposition product therefore is not soluble in cold acid aqueous solutions, and may, perhaps, be removed in a pure state by extraction from the aqueous solution, so that its chemical composition and reactions may be determined. The glucoside, purified by amylic alcohol, was used for the reactions, and some of these are most marked and appear characteristic.

When a small portion is dissolved in concentrated sulphuric acid, a yellow colour is at first produced, changing to yellow-brown, purplish on the edges after a quarter of an hour, purple after one hour, persistent for some time. This fine purple appears characteristic, and no trace of green is developed during the colour changes. When a portion is dissolved in nitric acid the colour is yellowish-brown, then pure yellow, which remains for some time.

Hydrochloric acid causes hardly any change, except perhaps a yellowish colour.

Aqueous solution gives no reaction with litmus paper (neutral).

KHO, NaHO, NH_3 to the aqueous solution, slightly yellow but very faint colour.

Fe_2Cl_6 gives no reaction, or slightly yellowish-brown.

Basic acetate of lead gives a white precipitate, slow in forming.

Neutral acetate of lead no precipitate.

Tannic acid gives a white or light-grey precipitate.

KI + I gives a light yellowish-brown precipitate in the aqueous solution, and darkens when acidified.

KBr + Br no precipitate until acidified (yellow).

$AuCl_3$ and $PtCl_4$ no change.

Picric acid no change.

$AgNO_3$ cloud, then white precipitate; this gradually darkens.

$CuSO_4$ no reaction.

$HgCl_2$ no reaction.

If to the aqueous solution a trace of Fe_2Cl_6 is added, the colour becomes yellow to brown, with a faint greenish tinge, but soon changes to purple, being bluish rather than reddish. This is not a satisfactory reaction. The most characteristic test is that with $K_2Cr_2O_7$. If a portion of the dry substance is dissolved in concentrated sulphuric acid, stirred, and to the purplish solution $K_2Cr_2O_7$ is added by dropping a minute fragment into the centre, the colour soon becomes sienna-brown, changing to green near the fragment. If now this fragment is moved away to one side of the liquid, portions are soon seen of a beautiful pure emerald-green colour. This reaction is a good one, but it must not be hurried. If an equal quantity of water is first added, stirred, and when dissolved H_2SO_4 added, and then a drop of solution of $K_2Cr_2O_7$ stirred into one-half of the liquid, a most beautiful emerald-green colour is soon developed in that portion, while the other part remains purple. Even in a dilute solution, if concentrated sulphuric acid is added, and then a drop of solution of $K_2Cr_2O_7$ is stirred in, the true emerald-green colour is soon seen, and it remains for some time before fading.

These reactions with sulphuric acid, and with sulphuric acid and $K_2Cr_2O_7$ in all solutions, are most marked and should be characteristic. The glucoside could not be removed from an aqueous solution with petroleum spirit, or ether, or chloroform, either in an acid or alkaline solution, with the exception of the chloroform in an alkaline solution, which removed a trace.

Petroleum spirit dissolved out from bark 1·275 per cent. of the original substance, but no bitter principle. When dried, ether dissolved ·637 per cent., principally a brittle resin.

Absolute alcohol dissolved 6·075 per cent., including some of the bitter principle, tannic acid, &c. The residue was tested for nitrogen, but none found. The material was then dried, and water dissolved from this equal to 9·4 per cent., consisting largely of gummy and mucilaginous matters; the remainder of the bitter principle is here found. From the above it is seen that by its action and mode of recovery it somewhat approaches the glucoside *Strophanthin*, by being so readily decomposed by all acids, even H_2S acting upon it; by its poisonous properties; by certain of its reactions. But it differs from that glucoside in that it is precipitated by basic acetate of lead, also by tannic acid; that it gives a precipitate with KI + I solution; by its difference in reaction with ferric chloride in sulphuric acid, and, most marked of all, its different reaction with concentrated sulphuric acid alone, and the beautiful emerald-green colour produced as described with $K_2Cr_2O_7$ and sulphuric acid. It is well, therefore, to provisionally name this new glucoside *Carissin.*

It has been a difficult matter to isolate the principle satisfactorily; but now that is accomplished, it will not be difficult to complete the investigation, and we hope shortly to have its chemical composition completed, and also that of its decomposition product. It seems at present as if it were impossible to crystallise it in any way.

10.—THE OINTMENTS OF THE PHARMACOPŒIA.

By F. W. SIMMONDS.

This subject is one that has not been much discussed, and there are a good many of the ointments of the British Pharmacopœia that are not satisfactory—at any rate, in this climate. The Pharmacopœia allows of too great liberty of interpretation, as in the case of hard paraffin, where the melting point is placed at from 110 degrees Fahr. to 145 degrees Fahr., also soft paraffin may either be white or yellow. I think that in the new addition of the Pharmacopœia, if these are retained as ointment bases, the melting point and colour should be stated in each case; or if it is intended that different samples should be used in winter and summer for the purpose of regulating the hardness, this should also be stated. This indefiniteness may make in some cases no difference in the therapeutic effect of the ointment; but it is often a source of annoyance to the patient as well as the doctor.

There is no doubt that a prescription dispensed by one chemist should not be different if repeated at a dozen different places. This is impossible if we all do just what we like; and, as there is nothing in the Pharmacopœia to define what colour the soft paraffin is to be, how can we dispense it so as to be sure that we are carrying out the wishes of the prescriber? The white variety is, I suppose, almost invariably used in those cases where the ointment would otherwise be coloured; but as some medical men have a dislike to this white variety (in some instances justly so, I think), perhaps we are unwittingly displeasing the prescriber by so doing. The formulæ of the Pharmacopœia preparations often get credit for being far worse than they really are; and I at least have often found that it is not the formula, but my unskilful manipulation that is at fault, so it does not do to be too hasty to condemn. The different degrees that hard paraffin melts at would account for some of the different opinions as to the method of making the ointments containing this base. I have not noticed that the critics had taken the melting point of the sample they were working with, for some say these ointments require no stirring as the melted paraffins are cooling. I could understand that, if the sample of hard paraffin selected had a very low melting point, this might be the case; but in my own experience a sample of medium hardness, melting at 125 degrees Fahr., formed with the soft paraffin two distinct layers on cooling, even when working on a small quantity. As the two paraffins do not form an intimate mixture, the B.P. directions about stirring till cool should be particularly attended to. To cool properly it should be done very slowly; the heat ought to be removed from the water bath (which should invariably be used for making ointments), and the ointment allowed to remain on the water bath, and the whole cooled together, keeping the ointment well stirred all the time. Ointments made with this base keep well enough, as long as no hot weather intervenes; should it do so the two paraffins separate, making the ointment rather unsatisfactory, which cannot be remedied except by heating up and cooling again. It sometimes happens that these ointments, although made very carefully, and to all appearances perfectly smooth mixtures, will be found, if a portion be rubbed on a slab, to contain small lumps, thus showing that the mixture is not an intimate one, and proving the importance of well stirring as it cools. They are also of such a waxy consistency that they are difficult to spread, and really require to be rubbed down each time they are used.

If beeswax be used in place of hard paraffin, the resulting ointment is much more homogeneous, thus requiring much less attention in making. Although it may melt at a higher temperature, it is a much better consistency for spreading, and being a more intimate mixture has not the same tendency to separate on the advent of the hot weather. I should like to see beeswax (either white or yellow, according to the colour of the ointment required) substituted for hard paraffin in all cases. Wax has also the advantage that genuine samples do not vary much in the melting points, so that it would be much easier to gauge the consistency of an ointment made with it.

There is much talk about wool fat as a universal basis; we are told that it should be used for all ointments. First it was wool fat, without any addition, that was to do away with all other bases; but it was soon pointed out that this was far from satisfactory on account of its stickiness. To meet this objection, soft paraffin was added to such an extent that it seemed hard to determine whether it is the wool fat or the addition that is so good. The mixture is also inclined to separate in hot weather. It was thought that wool fat, having the power to retain so much water, would act better than anything else for cooling ointments; but it was found that it held the water too tenaciously, and did not allow it to evaporate on the skin; so to make an effective cooling ointment, the wool fat should be mixed with oil, lard, or soft paraffin before the water is added. In mixing wool fat with soft paraffin, &c., without heat, the soft paraffin should be added gradually to the wool fat; otherwise there is some trouble in mixing them. I hope the revisors of the Pharmacopœia will not order the use of this basis for any but those few ointments where the old one is unsatisfactory. I admit that wool fat is very useful when it is desired to incorporate a liquid in an ointment; but how often is this required? The price also of wool fat would be against its being used universally, for, although cost does not influence us, yet to substitute an expensive article when the one in common use is just as good is not desirable.

In ointments, like other things, it is necessary to prove them for yourself. I made an ointment a few months ago of yellow oxide of mercury and lanolin ointment base; I thought it was sure to mix all right, as the reports all speak of the suitableness of this article for all chemicals that are unstable when mixed with other substances. For a few weeks I had no complaints; then I had it returned, as it caused a lot of irritation each time it was applied, which it did not at first, and I was rather surprised to find that all the yellow colour had disappeared. I do not know the cause of the change; but if it acts as a reducing agent in this case, why not in another? I also mixed some more with the same result.

Lard properly benzoated, although it is spoken of disparagingly, is hard to improve upon, and I think it deserves to still retain its place as the base of the majority of the ointments of the Pharmacopœia. In our summer it is rather soft, but this is easily overcome by adding beeswax. Very often the reason we give it a bad name for keeping is that we do not get the lard perfectly fresh, and benzoate it at once; and then very often we do not take the trouble to do it properly. Some recommend solutions of gum benzoin in spirit for the purpose, as saving much trouble. I have never seen so good an article made this way, because the spirit dissolves a great deal more of the colouring matter of the gum and imparts it to the finished product, which has also not anything like such a good aroma as it has when made by the official formula. The directions for making would be improved by adopting the U.S.P. method of loosely enclosing the gum in a coarse muslin bag, which is then suspended in the melted fat; if working with a large quantity, it would seem advisable to have the gum in, perhaps, two or three bags according to the size of the vessel. This I think a great improvement on just putting the gum in the lard, for it invariably cakes into a hard mass at the bottom, and is with great difficulty stirred, which, if not done properly, does not give the lard a chance of dissolving as much of the benzoin as is necessary to make a good preparation, and things that are a trouble are very often shirked. There are two important items to be attended to in making a good article: They are (1) that the heat should not be too great, otherwise the aroma is destroyed; and (2) that the benzoated lard should be stirred while it is cooling, for if anything but a small quantity is being made it granulates. The reason lard granulates after keeping is that, if the temperature rises enough to partly melt it, the stearine separates out on cooling, thus causing it to present the granular appearance. I have noticed that benzoated lard made at the beginning of winter keeps from granulating a much longer time than that made near summer time. When lard does granulate, nothing remedies it but remelting and properly cooling with stirring. I have also noticed that if beeswax is added to the lard in the hot weather, in sufficient quantity to prevent it melting at so low a temperature, it does not granulate. I should suggest for our climate the addition of 2 to 4 oz. of beeswax to 1 lb. of benzoated lard to those ointments that have it as a basis. This, by the way, is the "ointment" of the U.S.P. in the proportion of 1 of wax to 4 of lard, from which, no doubt, it will be thought I took the suggestion. Such was not the case, for I had found it answer before I knew of what "Ointment U.S.P." was composed.

Boracic Acid Ointment.—The present B.P. formula gives a fairly good preparation, if it is carefully mixed. In this case the sample of hard paraffin selected should have a medium to high melting point, as this ointment was introduced as a protective, and this object would be defeated were the melting point of the finished product too low. As a hard ointment is in this case required, this, perhaps, more than any other, would be improved by using beeswax instead of hard paraffin. A hard ointment is a great advantage over a soft one in some cases—burns, for instance, when dressings are allowed to remain undisturbed for a day at least. The hard ointment comes away easily, while the soft is generally absorbed by the skin and dressings, which are left sticking in the sore, and are often some trouble to remove. I have heard of this fact alone keeping back cases that should have got on all right, and did so as soon as the ointment was changed to a harder one. The boracic acid should always be put through a fine sieve before mixing with the base, but the method of sifting the acid over the melted fats is inconvenient and unnecessary. The acid should be put into the ointment before it is removed from the heat, to prevent the cold powder from suddenly chilling a portion of the ointment. Cool in the manner I have recommended; and it is not difficult in this way to make a nice smooth preparation instead of an unsatisfactory lumpy one.

Carbolic Acid Ointment.—The official formula is not satisfactory, as the acid does not dissolve readily in the paraffin; and although when first made the ointment appears all right, after a short time the acid begins to separate out, which with such a thing as carbolic acid is not at all desirable. It is a little better when made with beeswax instead of hard paraffin, but I should suggest its being made with benzoated lard and beeswax, in which the acid would dissolve.

Salicylic Acid Ointment.—The remarks on boracic acid ointment would apply to this also.

Aconitine, atropine, belladonna, calamine, gall, calomel, acetate of lead, iodide of potassium, iodoform, sulphur, and oxide of zinc ointments are made with benzoated lard, and, as I have before mentioned, require the addition of 2 oz. to 4 oz. of beeswax to the 1 lb., according to the climate.

Spermaceti Ointment.—The official form makes an ointment far too soft for this climate. I would suggest this as a suitable formula—Spermaceti 10, white wax 4, and benzoated lard 60.

Chrysarobin Ointment.—This ointment is best made without heat, for, although the chrysarobin in part dissolves in the hot fat, it is apt to crystallise out on keeping.

Nitrate of Mercury Ointment.—Of all the ointments of the Pharmacopœia this seems to give the most trouble and the least satisfaction; yet, by following the official directions precisely, a satisfactory article can easily be made which keeps without change for some considerable time. The consistency, however, when it is made with the proportions of lard and oil in the B.P., is rather soft for this climate. This is one of the ointments which I think cannot be had of a satisfactory consistency all the year round; it is either too soft in summer or too hard in winter. If the quantities of lard and olive oil are transposed, it makes a better ointment, which has, nevertheless, a tendency to granulate on keeping. What I have found more satisfactory, though at some seasons of the year a little hard, is—Mercury 1, nitric acid 3, lard $10\frac{1}{4}$, and yellow wax $1\frac{1}{2}$. To make a good preparation it is advisable to continue the heat until the effervescence ceases. This ointment made with vaseline cannot, of course, be the same as the official, being only a mixture of acid nitrate of mercury with the vaseline. All the samples I have seen of the mixture acquire a very disagreeable smell; and as some always use this preparation and no other, it is advisable to have a little in stock, for I know people who will not have any citrine ointment but that which smells like cockroaches.

Red Oxide of Mercury Ointment.—The official directions for making this ointment are wrong; the red oxide should be added to the melted fats while hot and stirred constantly till cold, and, as I have said before, I should like to see beeswax substituted for hard paraffin, as it then makes a very good ointment.

Iodoform Ointment.—As iodoform, according to Martindale, is only soluble in fats to the extent of about 1 in 60, would it not be better to mix it without trying to dissolve it, for, although it may be more soluble in the hot lard, it would be liable to crystallise out on cooling?

Tar Ointment.—This made according to the official directions is rather difficult to turn out well, as the wax cools in lumps on being added to the tar; but if the tar is carefully warmed and then the melted wax added, by stirring well a good ointment is made, although rather hard. What I have found better, and not half so much trouble to mix properly, is to replace half the beeswax with lard. There is one thing that should not be neglected in making this ointment, and is not mentioned in the B.P.—that is, it should always be strained, for if the heat be a shade too great the tar hardens on the bottom and sides of the vessel, and no amount of stirring will make it mix. These small lumps are perhaps hardly worth speaking about, unless it is required to mix with other ointments in dispensing; then they are very troublesome.

Resin Ointment.—The B.P. formula makes a good ointment, but contains too many ingredients, and at some seasons is too hard. I should like to see it altered to resin 4, wax 2, and benzoated lard 9, which makes an ointment in all parts just as good as the official one.

Simple Ointment.—The official preparation is too soft for this climate. If white wax 2 and benzoated lard 8 were used, it would answer better, and the ointments prepared with this base would then need no alteration.

Zinc Ointment.—The remarks I have to make on preparing this ointment will apply to those other ointments that contain powders, such as ammoniated mercury and carbonate of lead. Even after making this ointment very carefully, and it has appeared to be quite smooth, I have often noticed that when a small portion was taken out and spread on a slab, the ointment had small lumps of zinc oxide all through it. Mixing the oxide with a small quantity of the melted base in a warm mortar before adding to the remainder is an improvement on simply adding the oxide made very fine to the whole lot; but even this way it is necessary to strain the mixture, and rub down again that which does not go through the muslin. This is the only way I have been able to get an ointment quite free from lumps. Some time ago I had a pot of zinc ointment returned with the remark that they thought there must be some mistake about it, as they had had pounds of it at a time and it had, if anything, a rather unpleasant smell, whereas mine was quite nice. So I let them have a whiff of rancid lard, and asked them if that was it. "Yes," they answered, "that is how it should be"; and it was not very easy to persuade them that I was in the right. At any rate, I overcame their prejudice to such an extent that they took it on trial; the result was they were quite satisfied to have it repeated.

The directions for making ointments in the Pharmacopœia cannot very well be found fault with, except in one or two instances, as in the majority they are simply ordered to be mixed thoroughly. You can hardly improve on such instructions, and why the directions given for zinc ointment are not the same I do not know. There are only one or two cases where it is necessary to give instructions for mixing, for the object of the Pharmacopœia is not to teach us our business, but to let us know of what we are to make the preparations; and if we have the proportions, the making might very well be left in our hands, for, if we make a thorough mixture of the ingredients, what does it matter in which way we do it?

Just a word or two about making ointments without heat. There are a good many that are very seldom kept ready prepared, as they are not often required.

In mixing these ointments without heat, the powder (often lumpy) is sometimes placed on the whole of the base and rubbed down, with the result that it is with difficulty, if at all, that a smooth ointment is made. This takes just about three times as long as to do it the right way, which I think is this: Make sure the powder is not granular by rubbing it down in a mortar, then mix with a little of the base, and when this is quite smooth add the remainder gradually. In making these small quantities of ointments I always prefer using a slab and spatula to a mortar and pestle, as it is then much easier to see whether the ointment is smooth or not.

To repeat, then, the alterations that I think would be improvements on the preparations now official, speaking only for this climate, are: The addition of 2 to 4 oz. of yellow wax to the pound of those ointments made with benzoated lard; omission of the oil in simple and spermaceti ointments; using benzoated lard and white wax in the former case, and white wax, spermaceti, and benzoated lard in the latter; the substitution of beeswax for hard paraffin; the use of equal parts of benzoated lard and wax, instead of wax only, in tar ointment; the substitution of benzoated lard base for the one in present use in making resin and carbolic acid ointments; and the omission of heat in the making of chrysarobin and iodoform ointments.

11.—SOIL ANALYSIS.

By F. B. GUTHRIE, Chemist to the Department of Agriculture, New South Wales.

The analysis of soils constitutes a large part of the routine work of the chemical branch of the New South Wales Department of Agriculture, the number of complete analyses of different soils made during the four years of its existence being about 350, exclusive of a large number of which only a partial examination was made.

Concerning the value of soil analysis to the farmer, I am aware that there is considerable difference of opinion, some excellent authorities denying its value altogether, whilst there are not wanting those who go to the other extreme, and expect a chemical analysis to indicate both the nature and the exact quantity of fertiliser which is required to make the soil productive.

In this, as in most other debatable matters, I believe that the truth lies somewhere between the two extremes, and that a great deal can be learnt as to the proper treatment required from a rational system of analysis, which shall take into account the nature of the operations going on within the soil as well as its percentage composition.

That soil analysis, rationally conducted, has a considerable economic value I am convinced, and this conviction is strengthened by the continually increasing number of soils sent in for report from all parts of the colony, by the number already done, and, unfortunately, also by the arrears which accumulate.

Those who deny any value to soil analysis found their objections upon the means at present at our disposal in the laboratory of reproducing the natural condition of affairs going on within the soil; in other words, they argue that we cannot say what quantity of any given ingredient is in a condition in which it can be assimilated by the plant.

Let us hear what M. Ville says on the subject—"Chemistry is powerless to throw light upon the agricultural qualities of the soil, its resources and its needs, because it confounds in its indications the active assimilable agents with the assimilable agents in reserve, the active with the inert and neutral principles."

This is the conclusion he arrives at from the discussion of analyses which give the percentage composition of the soil together with the so-called mechanical analysis, the proportions of sand, clay, gravel, &c. M. Ville further points out that extraction with water yields results no less unsatisfactory, since the plant is able to utilise soil material which is insoluble in water.

In order to remedy this evil, the existence of which I suppose no one will be hardy enough to deny, various methods have been suggested and tried with the object of attacking the soil in a manner representing as nearly as possible the actual conditions which prevail in a field under cultivation. A few such reagents may be mentioned; they include water saturated with carbonic acid, oxygenated water, acetic acid, citric acid, and different salts, such as ammonium citrate.

In a recent series of researches Dr. Bernard Dyer* has experimented with a 1 per cent. solution of citric acid, which appears to approach closely, in its action upon the soil, the solvent power exerted by the acids secreted by the roots of certain plants. I venture to think that, notwithstanding the great scientific value of such a line of investigation, and of the light it may be expected to throw upon many obscure functions of plant-life, it leaves us pretty much where we were if we attempt to base upon its use any practical advice to the farmer as to the nature of the manures or other treatment his soil requires.

I am prepared to go a step further than M. Ville, and to say not only that we are unable to reproduce the agents at work within the soil in supplying the plant with food, but that we should gain very little from an economic point of view if we were possessed of them.

For, let us assume that the "universal solvent" has been found, that we are possessed of a reagent which exercises the same solvent action on the soil as, let us say, a wheat crop; in other words, one that dissolves from the soil the same amount of mineral and nitrogenous matter as the wheat crop will extract during the period of its growth. We are met with the following difficulties:—

Our wheat crop, though it contains less nitrogen (say, one-third less) than a crop of turnips, will nevertheless benefit very much more than the latter by an application of nitrogenous manure; that is to say, the wheat crop cannot make the same use of the nitrogen in the soil as the turnip does—exercises, in fact, a different solvent action upon the nitrogenous constituents.

Or, since the nitrogen in the soil is continually changing its condition, and there are external sources of nitrogen which may have some bearing in the above instance, we may take a case which is even less ambiguous.

The mangel crop removes from the soil nearly double as much phosphoric acid as the turnip crop does; nevertheless, manuring with superphosphate is of less benefit in the case of mangels than with turnips, the recognised reason being that mangels are able to utilise the phosphoric acid, as it exists in the soil, to a greater extent than turnips. So that it will be necessary for us to devise one solvent for turnips and another for mangels, one for phosphoric acid and one for potash—a separate set of solvents for every crop; and such a scheme, if it were feasible, would be far too cumbersome for practical purposes.

A second objection lies in the fact that the agencies at work within the soil are unceasing, and, as a consequence, the combinations in which the nitrogen and the mineral matter exist are also constantly changing. What is true of the chemical constitution of the soil to-day is no guide as to its constitution a week hence.

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* Journal of the Chemical Society, March, 1894.

The determination especially of the quantities of nitrates, of ammonium compounds, and of "organic" nitrogen provides us with no information to the purpose, for these, of all soil constituents, are most rapid in their changes.

Further difficulties present themselves in the large quantities of soil which it is necessary to employ in the determination of the substances soluble in water and weak acids, and the consequent length of time required for each determination, and also in the initial difficulty which presents itself in all soil analysis of ensuring the proper selection of a sample which shall represent anything but itself.

This difficulty, which is felt in all attempts to judge of the character of a soil from a given sample, applies more particularly to a chemical analysis, and increases in proportion as the quantities of the estimated substances diminish.

A chemical analysis alone, therefore, is of little value in guiding the farmer as to the requirements of his soil, and it is not in the refinement of chemical methods that we may look for help in this direction We shall, I believe, obtain much more valuable information if we can ascertain the conditions under which the fertility of the soil is maintained.

The fertility of a soil depends in the first place upon the presence of a sufficiency of plant food, and secondly upon certain properties, possessed more or less by all soils, which effect the splitting up of the mineral ingredients in such a manner as to render them available to plants, as well as regulating the supply of water, air, warmth, &c.

We shall discuss the most important of these properties, and shall find, I think, that they are capable of identification in the laboratory. A large number of those properties conducive to fertility are dependent upon the porosity of the soil; in other words, its fineness of texture.

By the porosity of a soil is meant the fineness and number of its pores. We must distinguish between this and permeability to water: a coarse sand, for example, being permeable to water, but possessing properties exactly opposed to those of a porous soil. Humus soils are especially porous. On the fineness of texture depend the following characteristics:—

The capillary power, by which is understood the power of imbibing water. This property maintains a continual circulation of water within the soil, and consequent aeration. It is, moreover, largely through the agency of this circulating water, which is charged with carbonic acid and different salts, that the mineral, and in a less degree the organic matter, of the soil is rendered available for plant food and presented in solution to the plant.

The capillary power of a soil depends very largely upon the fineness of its texture. The nearer the texture approaches that of a sponge the greater will be its capillarity.

Humus has a very high capillary power, which is not possessed to any extent by either coarse sand or clay.

This property is determined by filling a tube of known length with the finely powdered air-dried soil; the tube is open at both ends, the lower end being closed by a piece of fine muslin, and stands in water. At the end of twelve or twenty-four hours the height to which the water has visibly risen in the tube is read off. The determination presents no special difficulty, and I will not waste your time with long descriptions of this or other methods mentioned here. They are all capable of being rapidly and accurately performed.

The capacity of a soil for water is also of special interest, and depends partly upon its porosity, and partly on its content of organic matter. Peaty and humus soils, other things being equal, have the highest capacity for water, followed in order by marls, clays, loams, and sand.

The hygroscopic power—that is, the power of attracting water-vapour—is of practical importance in that it prevents undue evaporation, and prevents the soil from becoming parched up. It also serves as a guide to the absorptive power for other gases. This property, like capillarity, is due entirely to the fineness of texture, and the order is the same—humus, clay, loam, marl, sand, and coarse sand.

The absorptive power of the soil for salts is a factor of very great importance in determining the fertility of a soil.

This power which soils possess of removing saline matter from solution, and retaining it within their pores, is due partly to the chemical nature of the soil, resulting in a chemical interchange of basic constituents, and partly to its mechanical structure, the fineness of its texture, substances such as humus and clay possessing the power in a remarkable degree.

This property is determined by a method elaborated by Knop.

The absolute weight of the soil, though it has no bearing upon its fertility, is a point that should always be taken into account, since a heavy sandy soil, though it may contain a smaller percentage of fertilising material than a light clay soil, presents a larger mass to the plant in the same space.

We now come to the most important property possessed by soils, as affecting their fertility, and, at the same time, the most obscure, namely, their—

Power of Nitrification.—This property depends upon a number of points, on some of which our information is not very clear.

From what we know of the process of nitrification, we can lay down with tolerable certainty the following conditions as being favourable to the process:—

We must have free access of air and moisture, a certain degree of warmth, the presence of nitrogenous organic matter prone to oxidation (represented by humus). The presence of reducible mineral matter, such as sesquioxide of iron or metallic sulphates, is also favourable. A sufficiency of basic substances to combine with the nitric acid appears also to be advantageous to its nitrification.

Putting on one side the bacteriological aspect of the phenomena involved, we shall find that the formation of nitrates within the soil is due to oxidation, and that within certain limits the power of oxidation which a soil possesses is also the measure of its nitrifying power.

We are therefore, I believe, justified in assuming that a soil will be most favourable to the development of the nitric ferment which combines the following characteristics :—

1st. A fair proportion of humus.
2nd. A warm climate.
3rd. Provision for free access of air and of moisture (these depend upon its porosity, and are determined by its capillary power).
4th. Good drainage to prevent stagnant water accumulating.
5th. A certain proportion of basic substances.

It will be seen that beyond the presence of certain mineral and organic matter the conditions favourable to nitrification are those whose presence otherwise indicates fertility—namely, fineness of texture and absence of excessive water. If the capillary power of a soil is low, it indicates an unfavourable condition for nitrification.

It has recently been stated by a French writer that the presence of nitrates in the soil assists in rendering soluble the potash in such insoluble combinations as felspar, which is an additional mode by which the nitric organism promotes fertility.

Provided, then, that the condition of the soil, as indicated by the physical properties above enumerated, is favourable to what I may call the metabolism of plant food, its fertility will depend upon the amount of that plant food, and it is immaterial whether that food be now in a soluble state or not. If the mineral and nitrogenous matter are present in sufficient quantity, and the soil possesses high absorptive capacity, high capillary powers—in short, is of good texture and possesses the conditions conducive to nitrification—it may, I think, be fairly expected to prove a fertile soil ; and in cases where one or more of the conditions conducive to fertility are absent, we may look to improved methods of cultivation to attain that fertility.

The tabulated result of such an analysis as I have indicated would be as follows :—

Reaction of soil.
Weight of soil (per acre, 6 or 9 inches deep).
Capacity for water.
Capillary power.
Absorptive power for salts.

Mechanical analysis.

Gravel.
Sand.
Fine sand.
Clay.

Chemical Analysis (of fine soil).

Water.
Organic matter.
Nitrogen.

Soluble in strong boiling hydrochloric acid.	Lime. Potash. Phosphoric acid.

The quantity of organic matter (which is the volatile matter after deducting water and carbonic acid) affords a sufficiently close indication of the amount of humus present.

The nitrogen determined is total nitrogen. If nitrates are present, the modification of Kjeldahl's method is the most suitable.

I believe the above represents the fewest determinations on which an accurate judgment can be based.

I also believe that, with the aid of the above data, practical experience, and a modicum of mother-wit, thoroughly reliable and useful advice may be given as to the means to be adopted for ameliorating the soil.

The manures to be used and their quantities will to some extent depend upon the nature of the soil, and to a much less degree upon the quantities of fertilising ingredient found to be present, but principally upon the nature of the crop.

Soil analysis in the past has been too much occupied with the notion that the amount of fertiliser required depends upon the quantity already in the soil, and that nothing is necessary but to add so much of the particular ingredient in an available form as, together with what is already present, will produce a sufficiency for all requirements. I believe the principle is a sound one which tells us to manure the crop and not the ground, and that the soil is to be improved not by chemicals but by proper cultivation, by deep-ploughing, draining, liming, green-manuring, and other means of improving the texture, without which it is impossible to maintain the conditions essential to fertility.

12.—QUEENSLAND NATIVE ASTRINGENT MEDICINES, ILLUSTRATED BY THE CHEMISTRY OF THE GUMS OF EUCALYPTS AND ANGOPHORAS.

By Dr. JOS. LAUTERER, pract. Arzt., M.R.S.

Nearly 100 years ago, soon after Governor Phillip arrived on the shores of Port Jackson, the convicts engaged in cutting timber for their miserable dwellings noticed the gum exuded from the wounded bark of the Eucalypts, especially from that of the ironbark. The small community condemned by the laws to the vows of poverty and obedience, tried to derive some profit from every little discovery made in the new country; the gum was sent to England, and erroneously diagnosticated as a kind of "kino," nearly allied to Malabar kino. The ironbark gum, insoluble in alcohol in the dry state, but very easily dissolved by it when treated first with water, was then imported to Europe and sold along with Malabar kino under the silly name of "Botany Bay kino." As Allan Cunningham (1825) described our *Eucalyptus siderophloia* under the name of *E. resinifera*—a terminology now reserved for the "Jimmy-Low" (*E. resinifera*, Smith, 1790), which tree yields nearly the same gum as *E. siderophloia*—a double error runs now through the scientific books of the last decennium, purporting that *E. resinifera* yields the Botany Bay "kino." Martindale, speaking in his Extra-Pharmacopœia of the gum of *E. siderophloia*, even says: "This gum should be distinguished from the common Botany Bay kino, said to be the produce of *E. resinifera.*

The latter is very resinous (*sic*) and little soluble in water." From a medicinal point of view the true kinos (as well as rhatany and catechu) are very bad drugs. The astringent contained in them (the kinos) consists mostly of kino-tannic acid, which sticks only slightly to the mucous membranes, and is not even borne well by a weak stomach. If administered in an alcoholic solution the catechin and kinoin fall out in the organs of digestion as a strange body, having no affinity to albumen or gelatine, and only irritating the diseased inside of the bowels. The true kinos have nearly vanished from the medical practice on account of this, and in styling our Eucalypti and Angophora gums as kinos a blemish was attached to them from the first moment. "Have we not too many kinos already! Must we have another one from Botany Bay?" This was the outcry of the European pharmacists; and still how little did our Myrtaceæ gums deserve such a slander! Containing a noble tannate derived mostly from gallic acid, and being stained blue by ferric acetate, they unite easily and quickly with albumen and gelatine, and have the virtue to stick firmly to the mucilaginous membranes. Mouth, digestive organs, bronchial tubes, larynx, and nose are as kindly affected by the Eucalyptus gums as the whole skin of the body. The best Eucalypti gums are those containing a high amount of a kind of arabin, differing from true arabic acid in many respects. Still most pharmacists just reject those gums on account of their "insolubility in alcohol." The false terminology did not affect the pharmacists alone; it acted on the brain of the scientific chemists too. Nearly all the authors on the chemistry of Eucalypts—from the old writers up to Heckel and Schlagdenhauffen, in Marseilles, and to the recent Sydney chemists—speak of "kino-tannic acid" and "catechin" as occurring in the Myrtaceous gums, though not the slightest trace of these derivatives of proto-catechuic acid (stained green by ferric acetate) is to be found in them. Grimwade excepted, no modern writer on the subject laid any weight on the fact that the Myrtaceæ gums form blue precipitates (if properly diluted) with ferric salts, and none of them seems to be aware that they yield only pyro-gallic acid by dry distillation, and no catechol.

Ellagic acid, though nearly insoluble in alcohol, was mistaken for catechin, as in the instance of the Angophora gums, and of those of *E. maculata*, *E. corymbosa*, and many others. Ellago-tannic and eucalypto-tannic acid—nearly related (as Grimwade alone states) to querci-tannic acid—were misrepresented as "kino-tannic acid." Gallic acid was neglected altogether. A large number of gums has been worked out in this way since 1886, in the Proceedings of the Linnean Society of New South Wales, by Maiden, who gave an able classification of the gums, dividing them into three groups: (1) The gummy group, the gums of which contain no less than 40 per cent. of arabin; (2) the ruby group, the gums of which are entirely soluble in cold water and cold alcohol; (3) the turbid group, whose members are soluble in hot water or in hot alcohol, but the solutions become turbid on cooling.

I. The gummy group is represented in the Moreton Bay district by *Eucalyptus siderophloia*, *E. crebra*, *E. resinifera*, and *E. saligna*.

E. siderophloia, Benth.—From wounds in the deeply-furrowed, black, tough, heavy bark a gum plentifully exudes in long tears, pale and yellow at first, but soon darkening into bright red, brown, and black, and then becoming less and less soluble. It has a specific gravity of 138, is very hygroscopic, and contains between 15 and 20 per cent. of water, according to the moisture of the air. Very tough in the damp state, it is easily powdered if thoroughly dry. It dissolves nearly entirely in cold water, and a 10 per cent. solution has a specific gravity of 1·029. *Siderophloia* gum freed of 15-20 per cent. of water consists of no less than 42 per cent. of Eucalyptus arabin, forming the bulk of the gum in which the other constituents are dissolved and suspended, 28 per cent. of a tannin, 1·5 per cent. of gallic acid, and an undetermined amount of a soluble phlobaphene acting as colouring matter.

(1.) The Eucalyptus arabin is not identical with the arabic acid of the arabic gum, being much more soluble in alcohol. Acacia arabin is suddenly and entirely thrown out of a watery solution by alcohol, if only some grains of chloride of sodium or a few drops of hydrochloric acid are added. It is not altered by this reaction, and dissolves readily in water after the alcohol is poured off. Eucalyptus arabin, in opposition to this, suddenly falls out only by the addition of much strong hydrochloric acid to the alcoholic solution, and is thrown out by degrees, and in the lapse of some hours when salt or diluted hydrochloric acid is added. Its chemical composition is altered through this process; it becomes insoluble in water as an anhydrite, which we may call "Meta-eucalyptus arabin." Boiling with caustic potash restores its solubility. Eucalyptus arabin is so closely united to the tannin and the colouring matter, that, by throwing it out, those substances will go down united with it, and only anhydrite of the whole Eucalyptus gum will be obtained by the precipitation. In the same manner every reagent throwing out the tannin will take down the Eucalypto-arabin too. For instance, sulphate of cinchonine or strychnia precipitates the whole Eucalyptus gum; acetate of copper throws it to the bottom very suddenly, leaving the clear water in the bottle; whereas in a mixture of acacia arabin and tannic acid by the action of acetate of copper only the tannin is precipitated, being kept suspended in the solution of the unaltered arabin. Gelatine unites with the whole *siderophloia* gum to a mass looking very much like unvulcanised caoutchouc, which can be drawn out in long threads, as long as it is not dried up.

On addition of common salt, acetic ether takes the tannic acid and a lighter Eucalyptus arabin out of a watery solution of *siderophloia* gum. The arabin then is thrown out of that by alcohol, and it can be obtained in a pure state by this means. As the *siderophloia* gum contains 28·5 per cent. of tannic acid (see below), and as a watery 10 per cent. solution of *siderophloia* gum has a specific gravity of 1·029, we have only to subtract from this Hammer's specific gravity of a 2·8 per cent. solution of tannin to know the specific weight of the Eucalyptus arabin solution: 1·029 − 1·012 = ·017, indicating 4·2 per cent. of gum for the liquid, and 42 per cent. for the dry *siderophloia* gum. Any quick drying of the gum, as well as repeated dissolving and concentrating of the gum, is liable to alter it into metarabin, and to make it insoluble. In this manner old gums, contained under the bark of the tree for years, become only soluble by boiling them in an alkaline solution. By boiling a solution of *siderophloia* gum with hydrochloric acid the meta-eucalypto-arabin after some standing falls out, together with the soluble colouring phlobaphene, which is turned more yellow. By washing the precipitate in spirits the phlobaphene is separated from the metarabin, which, through the action of alkalies, is obtained soluble again. In this purified state it is precipitated by acetate of copper, which shows its near relation to vegetable slime. Indeed, a mucous digestion of *siderophloia* gum is obtained sometimes instead of a clear solution, if the gum is very slowly dissolved by cold water in the winter time.

(2.) The tannin of the *siderophloia* gum and of the gums belonging to this group might be called gum tannin. By different assays, including Löwenthal's process, I found the percentage in quite fresh undried gum not to be more than 28. The tannin is not related at all to the tannin of the Malabar kino—is not kino-tannic acid. By dry distillation it yields only pyro-gallic acid and no catechol, as the following experiment shows: One gram of *siderophloia* gum is heated for twenty minutes in three grams of pure glycerine to 200° C. A deep-brown solution of syrup consistence is produced, which is diluted after cooling with 20 grams of distilled water. Twenty grams of pure ether are added; the whole is well shaken and the ether taken off, out of which pyro-gallic acid is obtained in fine colourless needles, easily recognised when dissolved in water and acted upon by ferrous sulphate and limewater. As the arabin is liable to add impurities from "dry distillation," I repeated the experiment with purified *siderophloia* tannin and got the same results. The purple colour was still more distinct on addition of limewater to the pyro-gallic acid, obtained from the purer tannin. There are many reactions which establish a wide gap between kino-tannic acid and the tannin of the *siderophloia* group. The albumen of blood serum and fresh albumen of eggs is precipitated quickly by kino—very slowly by the tannin of *siderophloia* gum, resembling in this respect the querci-tannic acid.

The gum tannin is obtained in a pure state by saturating the solution of *siderophloia* gum with common salt, shaking it with acetic ether, and eliminating the Eucalyptus arabin through the addition of alcohol. The acetic ether is evaporated, and the gum tannin is dissolved in water. Its characteristic reactions are as follow: Caustic potash stains the solution pink; acetate of copper makes a dark-brown precipitate; copper sulphate gives a slight precipitate, which turns dark-brown by addition of ammonia. Limewater gives a pink or red-brown precipitate, whereas oak tannin gives a brown, and gallo-tannic acid a pale, precipitate, turning blue. Ammon. molybdate in nitric acid makes a dark-brown precipitate (gallo-tan., yellow colouration; oak tannin, greenish). Sodium sulphide gives a pinkish mixture (oak bark, brown; gallo-tannin, yellow). Lead nitrate makes a pink precipitate (oak bark, brown; gallo-tannin, white pr.). Acetate of uranium gives a brown precipitate like oak bark; gallo-tannin, crimson solution and brown precipitate.

The reactions come near those of querci-tannic acid, but they are all lighter, more pink than brown. From gallo-tannin it differs widely by giving a whitish phlobaphene when boiled with dilute hydrochloric acid. This phlobaphene is soluble in alcohol, and gives a pink solution with caustic potash. It has nothing to do with the phlobaphene of kino-tannic acid, which dissolves only slightly in alcohol and caustic potash. The gum tannin solution, by standing a long time, makes a whitish deposit insoluble in water and alcohol, and consisting of nothing else than ellagic acid, which is dissolved by caustic potash, with intense yellow colouration.

(3.) *Siderophloia* gum contains 1·5 per cent of gallic acid. For its determination the gum tannin is precipitated with antimon. tartar and chloride of ammonia. The filtrate is shaken with ether, the ether evaporated, and the gallic acid collected. As gelatine, like powdered hide, throws the gallic acid down in presence of gum, it is not reliable for the elimination of gum tannin. It can be assayed in a 10 per cent. solution of gum, freed from gum tannin by a method used by me, and based on F. Jean's method, to determine tannin from the volume of the gum solution used up to render a solution of iron chloride opaque. Cyanide of potassium cannot be used for the detection of gallic acid in those gums on account of the phlobaphene giving a similar reaction.

(4.) The colouring matter of the *siderophloia* gum is a soluble phlobaphene or anhydrite of the gum tannin. We can call it gum phlobaphene. It is precipitated by alkaloids, gelatine, acetate of lead, ferric salts, &c. In very dilute solutions, especially on a photographic opal plate, it shows its proper colour as a very delicate pink, condensed in more concentrated solutions to a light and then to a darker brown. It is very similar to the colouring matter of the Malabar kino, though this never shows such delicate pink tints even if diluted to the highest degree. The derivation of the gum phlobaphene from the gum tannin is distinctly shown in forming blue precipitates with diluted ferric acetate. Kino-red gives green colourations. Limewater does not throw out the colouring matter of the *siderophloia* gum; it only lightens its pink colour more, especially between the precipitated gum-tannate of lime. If now a ferric salt is added, the phlobaphene falls out with a delicate blue colour (turning brown). Alkalies make the pink phlobaphene lighter, changing it more to vermilion, especially carbonate of soda. Cyanide of potassium acts still in a higher degree on the colouring phlobaphene, imparting to it exactly the same colour as it does to gallic acid solution, and easily leading to mistakes. A permanent vermilion colour, by addition of potass. cyanide, never indicates gallic acid; the reaction is due to the gum phlobaphene. Malabar kino-red shows the same reaction to alkalies, and very likely the error in the books that it contains gallic acid is due to the vermilion colouration of the kino-phlobaphene, which by ferric salts is turned green. It must be noted that all light-coloured precipitates in *siderophloia* gum caused by gelatine, cinchonine, lead acetate, &c., are stained pink and, on addition of potass. cyanide, vermilion through the presence of this phlobaphene. In the fresh gum there are only traces of insoluble phlobaphene.

Eucalyptus crebra, F. v. M.—The bark of this tree looks very much like that of *E. siderophloia*. The gum exuded by it cannot be recognised from that of the common Brisbane ironbark, having the same chemical composition and the same properties as *E. siderophloia*.

E. resinifera, Sm.—This tree is called by timber-getters "Jimmy-Low," and its habitat nearest to Brisbane is the paddock adjoining Mr. Williams' Nursery, near Kuraby. It is not one of the ironbarks, but has a greyish, fibrous stringy bark, from which a gum is exuded resembling closely that of the two trees previously described.

The percentage of Eucalypto-arabin and gum tannin is the same too, varying in water and solubility according to the weather and the age of the gum. Of course, there is no kino-tannic acid contained in the gum, and the percentage as given by Staiger for the tannate is much too high. I found by different methods, including Löwenthal, only 24 per cent. of gum tannin stained blue by ferric acetate, and yielding pyro-gallic acid by dry distillation. Eucalypto-arabin is present at 50 per cent. The rest is water. The colouring phlobaphene is a little more red-brown than that of the ironbarks, showing a little less the delicate pink colour of the gum phlobaphene.

Eucalyptus saligna, Sm.—The tree is called grey gum. The bark is cast off very slowly, and the stem of the tree seldom looks clean. It yields very little gum; and this, as Mr. Maiden first observed, belongs to the gummy group. It agrees in all essential parts with the gum of *siderophloia*, only it seems to contain a little more of gum tannin, showing to me as much as 30 per cent. The colouring phlobaphene is not different from that of *siderophloia*, and the tannin yields pyro-gallol by dry distillation.

The gums of the whole group are of high medicinal value, especially for the organs of digestion and for the skin. They must never be administered in alcohol, though they are dissolved by it very easily if they are soaked in water first. They must be administered for internal purposes, as a fresh 10 per cent. solution of selected gum, of which 6 oz. can be taken in twenty-four hours. Scale preparations, as Dr. Joseph Bancroft recommended for purification of the gums, must never be made on tin. The tannate dissolves some of the metal, and makes insoluble and even poisonous precipitates when dissolved again. For external use a still stronger watery solution of treacle consistence is wanted. It will be found to be a splendid remedy for many things if used properly.

For tanning purposes the gums containing such a high amount of eucalypto-arabin are very inferior to other tans. The leather can lie in a strong solution of the gum for many weeks without being tanned at all, and without being able to take the eucalypto-tannic acid out of its combination with the eucalypto-arabin. The skin might even undergo a kind of maceration, and turn bad, when still a high percentage of tannin is left in the solution combined with the arabin, as I am convinced by many experiments.

II. The ruby group of Mr. Maiden is represented in the Moreton Bay district by the gums of *Eucalyptus hæmastoma*, *E. acmenioides*, *E. eugenioides*, *E. pilularis*, and *E. tereticornis*. All these gums contain between 60 and 70 per cent. of eucalypto-tannic acid, 7-8 per cent. of eucalypto-arabin, and 15-20 per cent. of water. The rest consists of impurities.

(1.) The eucalypto-arabin occurs in these gums mostly as metarabin, and settles to the bottom with the impurities. It is easily dissolved by caustic potash solution, and precipitated again by acetate of copper. The "insoluble phlobaphene" of some authors is this eucalypto-arabin united with eucalypto-tannin.

(2.) The tannin of this group agrees with that of the gummy group in every respect. It yields pyro-gallol by dry distillation, and has nothing to do whatever with kino-tannic acid. All reactions are identical with those of the gums of the first group. Boiled with dilute hydrochloric acid, the tannin yields the same phlobaphene.

(3.) The colouring phlobaphene agrees in every respect with the gum phlobaphene of the first group, cyanide of potassium especially, gives a beautiful vermilion, and ferric acetate a delicate blue colouration, in very diluted gum solutions.

(4.) Gallic acid was found by me to be present to 1-2 per cent. in those gums. It was assayed in the same way as that of the gummy group.

Respecting the medicinal value of these gums, it must be stated that they are the remedies most adapted to be used in the inhaler. A 10 per cent. solution is the fittest for this purpose. As an internal medicine, a 5 per cent. solution will generally do, but if it does not act quick enough there is no harm in dissolving half-an-ounce of the gum in a 6-oz. bottle, to be taken in twenty-four hours. For external purposes gums of this group might be mixed with two parts of gums of the *siderophloia* group, to strengthen the effect of those. Very good results have been obtained by me in this way.

III. The turbid group of Mr. Maiden contains a large number of gums in the Moreton Bay district, including *Eucalyptus corymbosa*, *E. maculata*, *E. tessellaris*, *E. microcorys*. It includes also the gums of the Angophoras—viz., *A. lanceolata*, *A. Woodsiana*, *A. subvelutina*.

The gums of this group are of the highest interest to the scientific chemist. They contain one or two tannins derived from gallic acid, and yielding pyro-gallol by dry distillation. None of the gums of this group contains the slightest trace of catechin or kino-tannic acid. They are all coloured blue by ferric acetate. Some contain a high amount of benzoic acid, which can be easily sublimated out of the fresh gum. A resinous matter is often present, derived from the tannin contained in them, or in some cases to be considered as derived from the essential oil of the leaves, and acting as mother substance to the tannin. We begin the description of these gums with that of the Angophoras.

(1.) *Angophora lanceolata* does not contain any essential oil in the leaves. It has a smooth bark much like that of *Eucalyptus maculata*, and resembles that of *E. tereticornis* and *E. hæmastoma*. Between wood and bark a gum is exuded, being lignified by rains and run into red brittle streaks. When dissolved in water, it behaves much like that of *A. subvelutina*, leaving a whitish insoluble powdery deposit. It dissolves to a great extent in hot water, but the solution always looks turbid. A pinky white precipitate occupies the whole volume of the liquid.

Angophora gum is partly soluble in cold water, and out of this clear solution, after some standing, a white powder is deposited, insoluble in cold alcohol, ether, and acetic ether. Under the microscope (750) it is seen to consist of a granular mass of ellagic acid, which dissolves in caustic potash with intense yellow colour, getting darker and darker till it approaches to blood-red. After a minute or two, groups of radiating needles of potassium glaucomelanate are formed, and single needles are seen to grow rapidly in the yellow solution of the ellagic acid. Fuming nitric acid dissolves the powder with intense crimson colouration, and sulphuric acid makes a yellow solution by addition of water. In hot alcohol the powder dissolves partly, and ellagic acid crystallises out by evaporating the solution. Ferric acetate stains the powder deep blue and then black. Chloroform dissolves this precipitated powder, and on evaporation sets down long crystalline needles of ellagic acid (at 750 enlargement). In cold alcohol the Angophora gum seems at first to be entirely soluble, but after a short time a white deposit resembling arabin is put down, which, when tested, proves to be nothing else but ellagic acid amounting to 4 per cent. of the gum.

In finding much ellagic acid in the Angophora gum we are induced to look for ellago-tannic acid as the mother substance, and to compare the reactions of a solution of Angophora gum with those of Myrobalans and Divi-divi, which hitherto were thought to be the richest source of ellagic acid.

Now, copper acetate makes a light-brown precipitate in fresh Angophora solution, not so light as with Myrobalans, but much lighter than with gallo-tannic acid. Copper sulphate makes a slight green precipitate (gallo-tannic acid no change), and on addition of ammonia a light-brown precipitate is formed. Limewater makes a yellow precipitate, turning purple like Myrobalans (gallo-tann., pale precip. turning blue). Ammon. molybdate in nitric acid produces a dirty yellow or dark-greenish precipitate like Divi-divi (gallo-tann., yellow). Lead nitrate gives a yellow-brown precipitate. These reactions show decidedly that Angophora gum contains a tannate most allied to that of Myrobalans and Divi-divi.

A watery solution of *Angophora lanceolata* gum, when filtered from the first deposit of ellagic acid, continues to make fresh deposits of this, until the ellago-tannic acid is quite exhausted, and until only the phlobaphene-yielding tannin is left, so that an old watery solution of *A. lanceolata* is stained only pink by HOK, whereas a fresh solution gets yellow and pink in a mixture.

By boiling a watery solution of Angophora gum with dilute hydrochloric acid, ellagic acid (insoluble in spirits) is obtained, showing clearly the presence of ellago-tannic acid in the gum. Three times as much of a red phlobaphene besides, soluble in alcohol, goes to the bottom after cooling. It is derived from a second tannin present in the Angophora gum. As much more of this second tannin is contained in the Angophora gum, it can be isolated by the fractioned addition of cold hydrochloric acid to a gum solution. The ellago-tannic acid, mixed with the other tannin (Angophora-tannin) is thrown out first, and the rest consists of a nearly pure solution of Angophora-tannin, yielding only phlobaphene if boiled with the hydrochloric acid. Borax and soda as well as cyanide of potassium and caustic potash produce now the same pinkish colouration in this Angophora gum solution, after the elimination of the ellago-tannic acid, as we used to see in the gums of the two previous groups. Copper acetate gives now a dark precipitate; limewater a dark precipitate, more bluish than with *siderophloia* gum. Ferric salts give a blue-black, ammon. molybdate in nitric acid a dark-brown colouration or precipitate. By shaking the Angophora solution with acetic ether after elimination of the ellago-tannic acid, the Angophora-tannin can be obtained pure. By dry distillation it yields pyro-gallol stained beautifully purple-blue by caustic potash, and purple-violet by limewater or ammonia, and giving blue colouration with ferro-sulphate, showing that it has nothing in common with kino-tannic acid. The phlobaphene obtained by boiling with hydrochloric acid is dissolved by borax with the same pink colouration as the kino-red. Still it is not identical with it, as is easily proved by the reaction with ferric salts. Besides that, kino-red dissolves only slowly in alcohol or alkalies, whereas Angophora-red is dissolved by those reagents very quickly. The phlobaphene behaves to reagents, if dissolved in alcohol, just as the Angophora-tannin does.

Angophora gum dissolves in boiling water to about 65 per cent. A residue of 35 per cent. settles to the bottom after cooling. Some chemists called this residue "catechin," of course without looking at it, because any schoolboy can see that it is not catechin. It consists—

(1) For the most part of ellagic acid ;
(2) Of a small amount (1-1·5 per cent.) of a resinous matter taken out of the residue by benzene, and stained blue-black with ferric acetate after continued washing ;
(3) Of a small amount of metarabin (1-2 per cent.) only, dissolved in hot solution of caustic potash ;
(4) Of bark and impurities.

An alcoholic solution of Angophora gum has a bright colour; and gets at once opalescent if diluted with water. It brightens up again when KOH is added. The fluorescent matter falls only out by addition of HCl, and swims to the top of the solution. It is nothing else but the small amount of resin and of ellagic acid which was dissolved in the alcohol. It is stained bluish by ferric salts. If chloroform is added to the opalescent liquid, it takes all ellagic acid up, and the bright solution swims on the top of the chloroform. The smell of the gum of *Angophora lanceolata* is due to a very small amount of an essential oil which resembles most the oil of camomile.

Angophora subvelutina, F. v. M., one of the apple-trees, grows plentifully on the Logan, near Waterford, and gives out a brittle reddish gum much used by settlers as a medicine for diarrhœa. Put in cold water it becomes whitish, some portion of astringent matter (Angophora-tannin and ellago-tannic acid) is dissolved, and a bulky whitish powdery substance subsides, which consists for the most part of ellagic acid.

Angophora intermedia, DC., and *A. Woodsiana*, Bail., agree in all respects closely with *A. lanceolata.*

The medicinal value of the Angophora gums must not be underrated. Of a 10 per cent. solution 6 oz. or 8 oz. may be given for diarrhœa in twenty-four hours. In the stomach the ellago-tannic acid is precipitated first and causes vomiting sometimes, but, if the stomach bears it, it is dissolved as well as the ellagic acid by the pancreatic juice and by the secretions of the intestinal tract. In this way it reaches sick parts of the lower bowels better than stronger gums.

By different methods, including Löwenthal's process, I found all the Angophora gums to contain about 40 per cent. of tannates soluble in water, and still they are better remedies for diarrhœa, especially for chronic forms of diarrhœa, than the gums of the ruby group. For external use they are very useful as wet applications in the form of cold compresses, but there is nothing in their favour compared with the gums of the ruby group in this respect.

Eucalyptus corymbosa, Sm.—This tree, called bloodwood, whose foliage does not contain any essential oil, has a persistent bark, and yields a gum in great plenty, exuding at times as a bright-red fluid of the consistence of treacle. It often becomes imprisoned between the layers of the wood, where it gets hard and may be broken out in quantity. It varies from being soluble in water to complete insolubility in water and alcohol. It dissolves in a fresh state to a large extent in cold water, and this solution, when filtered and quite clear, deposits, after some standing, a greyish powder insoluble in water and alcohol. It consists of ellagic acid, and dissolves in KOH with intense yellow colouration, and with formation of crystals of potass. glaucomelanate to be easily observed under the microscope. Still there is not so much deposited by a 10 per cent. gum solution as by a solution of Angophora gum of the same strength, and after the first deposit is formed it wants some weeks before a second deposit can be taken off.

Corymbosa gum contains 37 per cent. of soluble tannates. Addition of hydrochloric acid brings the tannates down, and after some time ellagic acid is formed in the deposit. Chloroform takes it out, and fines needles of ellagic acid are formed when the chloroform evaporates. The most part of the precipitate formed by hydrochloric acid consists of eucalypto-arabin, to which ellago-tannic acid and corymbosa-tannic acid is united. If boiled, the bulky mass collapses very much. Alcohol takes the phlobaphenes out of it; metarabin and ellagic acid are left. Cold KOH takes the ellagic acid out of the metarabin, which dissolves when boiled in the KOH solution.

The tannin proper to the gum of *E. corymbosa* (besides the ellago-tannic acid) is obtained pure by throwing out first the ellago-tannic by HCl, then by precipitating the other tannin with salt or by the addition of more HCl, and by extracting this last precipitate with acetic ether. Its reactions are similar to those of the diluted *corymbosa* gum solution. Ferric salts produce a light-blue, turned into Indian red by addition of liquid ammonia; ferrous salts stain the solution bright blue; copper acetate produces a greenish-brown, as most of the other reagents do. If boiled with dilute hydrochloric acid this tannin forms a phlobaphene nearly allied to the phlobaphene of Angophora gum. Dry distillation yields pyro-gallol.

The residue in the watery solution of *corymbosa* gum does not contain any catechin. The turbidity of the boiled solution is due to *débris* of the bark, and to ellagic acid insoluble in spirits. The medicinal value of this gum is not so high as that of the Angophoras. It may be used in the same way as the gum of those, but perhaps in a stronger dose, as I found by experience.

Eucalyptus maculata, Hook.—The spotted gum is a tall tree with deciduous bark and plenty of oil-cells in the leaves, which yield an essential fragrant oil, especially in the variety *E. citriodora.* The wounded bark throws out a brown treacle-like gum, which hardens into large masses. When these are disturbed they give off an aroma-like gum benzoin. During the rain the gum softens and whitens, and has a remarkable appearance on the trees. When dry the colour again becomes brown. Cold water dissolves only a small amount of this gum, and the percentage of soluble tannates is not higher than 10, as already Grimwade has stated in the "Pharmaceutical Journal," 17th June, 1886.

After long standing a watery solution of *E. maculata* gum makes a sediment of ellagic acid without any admixture of Eucalypto-arabin. An old watery solution reads as follows :—

KOH makes a yellow colouration, turning blood-red inside, green outside (on an opal plate).

Ferric acetate gives a beautiful blue colouration,

Cupric acetate makes a light-brown precipitate; cupric sulphate, a light precipitate, browner by addition of liq. ammon.

Limewater makes a yellowish precipitate, turning purple-brown.

Sulphide of sodium gives a deep yellow colouration; lead nitrate makes a yellow precipitate; uran. acet. gives a red-brown mixture; and ammon. molybd. in nitric acid, a yellow-brown precipitate.

Antimon. tartar, no change.

A clear watery solution, boiled with dilute HCl, makes a precipitate, which, on addition of alcohol, is partly dissolved. The soluble part—phlobaphene of eucalypto-tannic acid—is stained beautifully pink by addition of KOH. The grey insoluble part consists of ellagic acid, and dissolves with intense yellow colouration in KHO. Sometimes a fresh cold solution gives a sediment entirely dissolved in alcohol, and consisting of phlobaphene only, after boiling with hydrochloric acid.

The soluble tannins are—(1) Ellago-tannic acid, always present in old solutions; (2) eucalypto-tannic acid, coming near to querci-tannic acid, as Grimwade already observed.

The residue which is left in cold water dissolves partly in alcohol. A remnant of 25 per cent. of the whole gum is left undissolved. It consists of pure ellagic acid. The alcoholic solution consists now—(1) of two tannates; (2) of a resin; (3) benzoic acid; (4) a very small amount of cinnamene derived from the benzoic acid, and not present in all gums. Of the tannates we have already spoken. The resin was thought by Mr. Staiger to be identical with shellac, to which it bears some superficial resemblance, not being dissolved in benzene; but it has nothing to do with shellac at all. It softens very much in water, and really a part of it is dissolved and stained blue by ferric salts, and pink by KOH. It dissolves freely in ether, where the Alpha-and Beta-resin of shellac are quite insoluble. It dissolves in acetic ether, which does not affect shellac. Finally it is dissolved by weak KOH solution, with deep yellow colouration; and on neutralisation with an acid it gets stained blue-black by ferric salts.

Moreover, if the solution of the resin is watched under the microscope only for a few minutes, crystals of glaucomelanate of potassium are seen separating quickly. All this shows plainly that in the resin of *E. maculata* we must recognise a resinous body derived from a tannate (tan resin)—namely, from ellagi-tannic acid—as similar resins have been found by Schlagdenhauffen ("Pharmaceutical Journal," 1892, page 4, and 1893, page 5).

The benzoic acid can be sublimated out of fresh gum, or out of the gum dissolved in spirits after evaporation of the alcohol. It is present in fresh gum at 2 per cent. It crystallises in beautiful rhombic plates, which melt when heated to globular drops, each of which after cooling is reconverted into a crystal. It dissolves in alcohol and alkaline water; has the pungent taste of the pure acid, and the irritating smell of this when heated. Ferric salts stain the solution with a reddish-yellow precipitate, showing them to consist of benzoic acid.

Dry distillation of the gum of *Eucalyptus maculata* furnishes pyro-gallic acid. No trace of kino-tannic acid or of catechin is present in fresh or old gum.

As benzoic acid is a powerful antiseptic, the gum of *E. maculata* dissolved in water can stand for a year or longer without being altered. No fungi grow on it, whereas on a solution of the gums of the "gummy group" a thick layer of *Penicillium glaucum* and *Mucor mucedo* is formed after a few weeks.

For internal purposes the *maculata* gum is not to be adhibited. Its smell is disliked by nearly everybody. Still I know a case where chronic inflammation of the bladder was cured by its use. For external application in the wet state, a solution of the gum in borax and water is a powerful antiseptic and healing agent; but it has the drawback, like all tannates, to stain linen and so to destroy the bedclothes, &c., in a bad way.

13.—NOTES ON A BLOCK OF PORTLAND CEMENT (SET FOR NEARLY FIFTY YEARS).

By W. M. DOHERTY, F.C.S., Government Laboratory, New South Wales.

The important part played by this useful substance wherever civilisation exists in an advanced form, and its ability under more or less well-defined conditions to resist the disintegrating power of time, renders any contribution touching such a phase of the subject as these notes embrace a matter of interest. My present contribution consists of the analysis of a block of cement, the history of which is thus outlined:—

Forty-five years ago the cask which originally contained the block became accidentally wet. The cement became consolidated in the cask and was discarded, to lie half-buried in the ground for twenty years. From that time until a few years ago it was utilised to form the corner-stone of a weatherboard cottage; and during the last few years the block has again been exposed to the open air. The block was extremely hard and difficult to fracture, resisting for a considerable time the repeated blows of a heavy sledge-hammer. On the outside it was of a lighter shade of colour than cement as it is commonly known; but on breaking through the outer portion it was at once seen that this whitish colour was merely skin deep—in its thickest parts penetrating not more than a quarter of an inch into the block. Under this skin the usual Portland stone shade presented itself. Analysis of this whitish outer skin revealed the fact that the lime therein contained was almost wholly in the state of carbonate, yielding 35 per cent. of CO_2, while the inner portion of the block contained only from 2 per cent. to 5 per cent., varying in the lesser degree as the interior was reached. On the outside the decomposition of the silicate of lime into carbonate had formed a covering which effectually protected the inner part from the further action of the CO_2 of the atmosphere, and of the water which, with almost every shower of rain, beat upon or surrounded the block periodically for years.

The following are the figures obtained on analysing the substance of the inner portion of the block :—

Total loss on ignition	16 67	per cent.
Loss at 100° C.	5·80	"
Total OH_2	14·67	"
OH_2 of hydration	8·87	"
CO_2	2·00	"
Total CaO	50·96	"
Free CaO	12·65	"
SiO_2	20·30	"
Fe_2O_3	2·40	"
Al_2O_3	4·10	"
$CaSO_4$	4·02	"
CaS	·27	"
MgO	·40	"

Specific gravity, 2·326.

Upon calculating the above result, water free, the composition of the cement before hydration took place was found to be as follows :—

SiO_2	24·36	per cent.
Fe_2O_3	2·88	"
Al_2O_3	4·92	"
So_3	2·83	"
CaS	·32	"
MgO	·48	"
CO_2 alkalies, &c. (by difference)	2·56	"
CaO	61·65	"
	100·00	

These figures agree closely with those obtained from old samples of cement made in England, and analysed from time to time.

An interesting point in the analysis of the block is the quantity of free lime therein stated. Almost the whole of this free lime was found to be soluble in water, and throughout all portions of the block, except at the outside, the alkaline reaction was well marked. One-fourth of the total lime present existed in a condition extremely liable to be converted into carbonate, and yet during the greater part of half a century this action has been prevented. The existence of so large a proportion of free lime in a block of cement which has withstood so well the action of time is in itself remarkable.

All the authorities agree that the setting of cements is due to the formation of hydrated silicates, aluminates, and ferrite compounds of lime; and that, in the event of these combinations failing to take place properly, the disintegration of cements occurs as a natural consequence.

But in the present instance we have one-fourth of the total lime combined with neither the SiO_2, Al_2O_3, nor Fe_2O_3, and the cement subjected to the action of air and water for nearly fifty years yet retaining its tensile strength in a marked degree.

One conclusion to be drawn from this analysis is, I think, that the block has been unusually well protected by the outer skin of carbonate of lime; and the presence of so much free CaO has helped rather than retarded the preservation of the block by filling up its outer pores.

The cement, as the water free calculations show, was unmixed with any foreign material, and the conditions of setting not therefore the same as would hold in ordinary use.

A remarkable fact is that a second block of cement, belonging to the same lot as the one which forms the subject of my analysis, was found to have its lime contents entirely changed into carbonate, and to readily break up on the slightest tapping of a hammer, the two blocks having apparently been exposed to exactly the same external influences.

14.—ON A METHOD OF SHORTENING CERTAIN CHEMICAL CALCULATIONS.

By W. A. HARGREAVES, M.A., B.C.E.

In estimating the quantities of gases, it is frequently necessary to reduce the volumes to the normal pressure and temperature—that is, to a pressure corresponding to a height of 760 millimetres of mercury and to a temperature of 0° Centigrade, or, as it is more convenient in these calculations to express it, to 273° absolute temperature. Again, it may be required to find how many litres (V) of a certain gas may be obtained at a particular time under the ordinary or other pressure and temperature of the air, which we may designate as pressure P and temperature T (absolute).

If T be the absolute temperature corresponding to t° Centigrade, then $T = (273 + t)$.

Now, in working out the equation representing the reaction which produces the gas, the quantity of gas produced is obtained in grammes weight. Two operations are then necessary—first, to convert grammes to litres at 0° C. and 760 mm.; and, second, to reduce the number of litres so found to the volume V at pressure P and absolute temperature T.

In order to do this the text-books give formulæ which are, in every case that I have seen, difficult to retain in the memory, and more or less tedious in application.

For the following proposition I am indebted to my lecture notes taken at Melbourne University:—

"If V be the volume of gas under a pressure P at an *absolute* temperature T, then, no matter how the volume, temperature, and pressure be changed, $\frac{V\,P}{T}$ remains a constant."

This can be easily proved, for if V' be the volume of the same gas under a pressure P', and an absolute temperature T', then, if the pressure change from P to P' while the temperature remains constant and v be the resulting volume, by Boyle's Law,

$$V\,P = v\,P' \ldots\ldots (1).$$

If, now, the temperature of the volume v change from T to T', while the pressure (P') remains constant, and V' be the resulting volume, then, by Charles' Law,

$$\frac{V'}{v} = \frac{T'}{T} \ldots\ldots (2).$$

Hence, by (1) and (2),

$$V'\,P' = \frac{V\,P\,T'}{T},$$

and

$$\therefore \frac{V'\,P'}{T'} = \frac{V\,P}{T}.$$

Thus, $\frac{V\,P}{T}$ has a constant value.

I have found that by adapting this result to the calculations in question the work is greatly facilitated, and there is less liability to error. In the hope, therefore, that this may prove of service to others, I submit these notes.

Remembering that $\frac{2}{\cdot0896}$, or 22·32 litres of any gas weigh its molecular weight expressed in grammes, we may work out, once for all, the value $\frac{V\,P}{T}$.

$$\frac{VP}{T} = \frac{22{\cdot}32 \times 760}{273} = 62{\cdot}14.$$

Hence $V = 62{\cdot}14 \times \frac{T}{P}$.

Where V is the volume in litres of an amount of any gas which weighs its molecular weight when expressed in grammes, when under a pressure of P mm. and at an absolute temperature T.

This result is readily applied, as the following example shows:—

Suppose that it is required to find what volume of nitrous oxide at 15° C. and 740 mm. is given by 30 grammes of ammonium nitrate.

Here T = 273 + 15° C. = 288° and P = 740 mm.

$$NH_4NO_3 = 2H_2O + N_2O,$$
$$80 = 36 + 44,$$

∴ 80 grammes of ammonium nitrate give 44 grammes of nitrous oxide

∴ 80 grammes of ammonium nitrate give $62{\cdot}14 \times \frac{288}{740}$ litres of nitrous oxide at 15° C. and 740 mm.

∴ 30 grammes of ammonium nitrate give $62{\cdot}14 \times \frac{288}{740} \times \frac{30}{80}$ litres of nitrous oxide at 15° C. and 740 mm.

∴ 30 grammes of ammonium nitrate give 9·069 litres of nitrous oxide at 15° C. and 740 mm.

9·069 litres. *Ans.*

It will be seen that this formula $V = 62{\cdot}14 \times \frac{T}{P}$ lends itself conveniently to the use of logarithms whereby the labour of multiplication and division is obviated. Log. 62·14 = 1·79337.

15.—SOME REMARKS ON THE TEACHING OF ELEMENTARY CHEMISTRY.

By A. J. SACH, Goulburn.

Section C.

GEOLOGY AND MINERALOGY.

1.—REPORT OF SEISMOLOGICAL COMMITTEE.

Members of Committee :

Mr. A. B. Biggs	Mr. H. C. Russell
Mr. R. J. L. Ellery	Sir C. Todd
Sir James Hector	Mr. G. Hogben (Secretary).

There has been little of importance to record since the last report.

It is satisfactory to note that besides the use that has been made of our records of earthquakes by the Secretary, other workers have had recourse to them—*e.g.*, Mr. Charles Davison (paper read before Royal Society of England) and Dr. von Rebeur-Paschwitz, of Merseburg. We feel sure that by continuing the careful record of seismological phenomena in Australia we are compiling materials for useful scientific work in the future.

Dr. Rebeur-Paschwitz has placed one of his celebrated horizontal pendulums at the service of the Association. We trust that the latter will see its way to accept the generous offer.

The tables annexed to this report bring the records down to the end of 1893.

EARTHQUAKE SHOCKS IN SOUTH AUSTRALIA, 1893.

* Time verified by A.M.T.: A=A.M.; P=P.M.

Date.	Place.	Time of Beginning of Shock (Adelaide Mean Time).	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity (Rossi-Forel Scale).
1893.						
Jan. 17	Redruth ...	4·39 A	S. to N. (or N. by E.)	2 secs. each.	Slight shaking of house	III. +
June 28	Warrina ...	4·45 A 7·44 P*	S.E. to N.W.	1 sec.	Slight, but distinct; rumble 3 seconds before, dying away in N.W. 3 secs. after	III. to IV.
July 2	Eucla	2·15 P*	S.E. to N.W.	About 10 secs.	Slight; vibration of buildings	III. to IV.
„ 4	Kapunda ...	12·20 A*	S. to N.	About 10 secs.	Slight	III.
Aug. 13	Eudunda ...	11·45 A*	...	About 10 secs.	Rattling of windows	III. to IV.
„ 13	Freeling ...	11·40 A*	N.E. to S.W.	About 4 secs.	Windows vibrating; low rumbling preceding and accompanying	III. to IV.
„ 13	Angaston ...	About 11·30 A	S.E. to N.W.	About 1 min.	Rather sharp	III. to IV.
„ 13	Friedrichswalde	11·44 A*	N.W. to S.E.	9 secs.	Sharp	III. +
„ 13	Riverton ...	11·45 A	N to S.	5 secs.	As if heavy trap were driven by rapidly	III. +
„ 13	Kapunda ...	11·45 A*	S. to N.	About 10 secs.	Sharp; rattling of windows very marked ...	IV.
Oct. 24	Beltana ...	1·6 P*	N.W. to S.E.	2 secs.	Slight; veranda trembled; building vibrated strongly	III. to IV.
Nov. 3	Redruth ...	6·21·2 P	S. to N. (slightly W.)	...	Slight; tremble of veranda	III. +
Dec. 9	Warrina ...	11·26 A	E. to W.	2 secs.	Slight here, but severe 10 miles N. (? bridge damaged)	III. to IV.

EARTHQUAKE SHOCKS IN NEW ZEALAND, 1893.

*Time verified: A=A.M.; P=P.M.

Date.	Place.	Time of Beginning of Shock (N.Z. Mean Time).	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity (Rossi-Forel Scale).
1893. Jan. 3	Wanganui ...	9·52 P	S.W. to N.E.	About 30 secs.	Loud rumble and sharp vibrations...	III.+
,, 12	Auckland‡ ...	...	...	...	Slight	
,, 13	Wellington‡ ...	...	...	...	...	
,, 17	Wanganui ...	10·55 P	S.W. to N.E.	...	Rather loud rumble, followed by moderately sharp vibrations, dying away very gradually in about a minute	III.+
,, 28	Wellington ‡ ...	...	...	...	...	
,, 29	Palmerston N.‡	...	...	...	Smart	
Feb. 10	Manaia ...	2 A*	N.E. to S.W.	About 1 sec.	Slight	III.
,, 10	Wellington‡ ...	...	...	...	Slight	
,, 12	Nelson... ... (And generally from Dunedin to Kaipara)	8·1½ A*	S. by W. to N. by E.	About 1 min.	A severe earthquake from an origin 5 or 6 miles S. and W. of Nelson. For details see N.Z. Institute Trans., 1893, p. 347 (Hogben, Nelson Earthquake)	VIII.+
,, 18	Wellington‡ ...	...	...	...	Slight	
Mar. 1	Wangaehu and Turakina Valley	About 1 P	...	...	Sharpest for years	V.
,, 1	Wanganui ...	2·12 P	...	4 secs.	...	IV.
,, 8	Opunake ...	1·50* P	S.E. to N.W.	2 secs.	Slight	III.
,, 9	Opunake ..	2·30 A	E. to W.	2 secs.	Slight; slight rumbling	III.
,, 9	Wanganui ...	About 2 A	...	A few secs.	Slight	II. to III.
,, 9	Wanganui ...	11 A	...	30 secs.	Slight	III.
,, 9	Wanganui ...	2·15 P	...	A few secs.	Slight	II. to III.
,, 9	Opunake ...	3·56 A*	E. to W.	4 secs.	Sharp	IV.
,, 17	Rotorua‡ ...	...	...	...	Slight	
,, 17	Wellington‡ ...	...	...	...	Slight	
,, 21	Greymouth ...	11·21 A	N. to S.	...	Slight. *Newspaper*	III.
Apl. 21	Napier... ...	10·26 A	...	2 to 3 secs.	Sharp	III.+
,, 21	Feilding ...	10·26A*	E. to W.	...	Slight; only a single lurch	III.

‡ From Sir James Hector's List, in Transactions of New Zealand Institute, 1893, App., p. 691.

EARTHQUAKE SHOCKS IN NEW ZEALAND, 1893—*continued.*

* Time verified : A=A.M. ; P=P.M.

Date.	Place.	Time of Beginning of Shock (N.Z. Mean Time).	Apparent Direction.	Apparent Duration.	Effects—Remarks.	Intensity (Rossi-Forel Scale).
1893. Apl. 21	Wanganui ...	10·27 A*	N.E. to S.W.	5 secs.	Sharp ; lamps swinging, crockery rattling ; loud report and rumbling	IV.+
,, 21	Woodville‡ ...	...	...	...	Slight	
,, 21	Wellington‡ ...	...	...	...	Slight	
May 1	Rangiora ...	6·29 A*	E.S.E. to W.N.W.	10 to 18 secs.	Sharp ; rattling of furniture ; followed by slight tremor 4 to 5 min. later	IV.
,, 1	Ashburton ...	6·27 A*	S. to N.	About 5 secs.	Sharp	III.+
,, 1	Greymouth ...	7·30 A*	...	...	Very slight	II.
,, 1	Christchurch‡	...	...	...	Slight	
,, 1	Lincoln‡ ...	...	..	...	Slight	
,, 1	Lyttelton‡ ...	...	...	...	Smart	
,, 10	Lyttelton‡ ...	...	...	...	Slight	
,, 11	Rangiora ...	6·7 A	W.N.W. to E.S.E.	2 to 3 secs.	Slight	III.
,, 12	Wellington‡					
,, 13	Wellington‡ ...	...	...	...	Smart	
,, 18	Wanganui ...	3·30 A	N.E. to S.W.	30 secs.	Sharp ; small boxes thrown off shelves ; rumbling ; rocking motion	VI.
,, 18	Wellington ...	3·27 A*	...	...	Two shocks, first prolonged ; woke sleeper ; rattled crockery ; two sharp explosions	V.
,, 18	Nelson ...	3·29 A*	N.E. to S.W.	3 to 4 secs.	Two shocks, 30 secs. between them	IV.
,, 18	Greymouth ...	3·20 and 3·30 A	...	...	First sharp, second slight	III. to IV.
,, 18	Collingwood ...	3·30 A	...	About 15 secs. each	Two sharp shocks	III. to IV.
,, 18	Blenheim ...	3·27 A*	N.E. to S.W.	30 secs.	Two sharp "shocks" (? maxima), 20 to 30 secs. between ; continued oscillation	III. to IV.
,, 18	Marton ...	3·27 A*	N.E. to S.W.	10 secs.	Moderately sharp ; preceded by slight tremor ...	III. to IV.
,, 18	Feilding‡ ...	...	...	...	Smart	
,, 18	Danevirke‡ ...	...	...	...	Smart	
,, 18	Lyttelton ...	...	...	...	Slight	
,, 20	Queenstown ...	1 A*	N.W. to S.E.	4 secs.	Telegraph clock stopped at 1 A. ; also many others ; crockery rattled	VI.
,, 20	Invercargill ...	1 A*	S.W. to N.E.	45 secs.	Clocks stopped ; severe ; a very slight shake at 1·20	{ VI. III.–
,, 27	Wanganui ...	12·9 A*	N.E. to S.W.	10 secs.	Sharp ; much rumbling	III. to IV.

May 27	Wellington‡ ...	...	...	...	Slight	
June 15	Wellington‡ ...	...	...	...	Slight	
,, 22	Nelson ...	3·29*	...	2 secs.	Very slight, but felt by several people	III.
July 14	Nelson ...	2·2 P	S.E. to N.W.	3 secs.	Slight	III.
,, 14	Napier.. ...	7·46 P	...	3 secs.	Sharp	III. +
,, 30	Blenheim ...	2·20 A* 5·40 A*	... ...	3 secs. each	First shock preceded by tremors; both slight ...	III. −
Aug. 4	Wellington‡ ...	2·44 A*	N. and S.	About 3 secs.	Sharp; rumbling	III. +
,, 6	Wanganui ...	3·20 A	S.W. to N.E.	...	Loud explosion, sharp jolt, followed by three or four vibrations	III. to IV.
,, 11	Wellington‡ ...	...	...	...	Slight	
,, 11	Pahiatua‡ ...	...	...	...	Smart	
,, 12	Tauranga ...	7·44 P*	N. to S.	30 secs.	Buildings shook violently; sash-weights struck quickly and heavily; severe, followed by slight tremors and shocks for 40 minutes; sea on beach made peculiar hissing noise	V.
,, 23	New Plymouth	3·30 A	S.E. to N.W.	10 secs.	Sharp; accompanied by rumbling	III. to IV.
Sept. 8	Wellington ...	6.20 P	N.E. to S.W.	5 secs.	Two shocks; slight	III.
,, 8	Wanganui ...	6·20 P*	S.E. to N.W.	20 secs.	Smart; slight rumbling	III. +
,, 8	Blenheim ...	6·20 P*	...	2 secs.	Slight	III.
Oct. 11	Wellington ...	About 3 A	...	...	Slight	III. −
,, 11	Pahiatua‡ ...	...	...	...	Smart	
,, 24	Wanganui ...	3·17 A*	N.E. to S.W.	30 secs.	Prolonged; slight	III. +
,, 24	Marton‡ ...	...	...	...	Smart	
,, 24	Feilding‡ ...	...	...	...	Smart	
,, 24	Shannon‡ ...	...	..	...	Smart	
,, 24	Pahiatua‡ ...	...	...	...	Smart	
,, 24	Woodville ...	...	...	...	Smart	
,, 24	Masterton‡ ...	...	...	...	Smart	
,, 24	Wellington ...	About 3 A	...	...	Slight	III. −
,, 29	Wanganui ...	4·24 A*	S.W. to N.E.	8 secs.	Rang bells of telephones. Very loud "explosion" (Field), or "rumbling" (Mountfort), followed by vibrations for 45 secs.	V.
Dec. 7	Opunake ...	3·38 A*	E. to W.	2 secs.	Slight; slight rumbling	III.
,, 8	Opunake ...	12·49 P*	E. to W.	3 secs.	Building creaked; crockery rattled; sharp ...	IV.
,, 9	Wellington‡ ...	...	...	...	Slight	
Sept. 23	Bua, Fiji ...	4·30 A 5·55 A	S.W. to N.E.	Several seconds	Sharp; bed shook, house rumbled. (Rev. J. P. Chapman.) Bua is 16 degrees 48 minutes S.; 178 degrees 37 minutes E.	IV.

‡ From Sir James Hector's List, in Transactions of New Zealand Institute, 1893. App., p. 691.

EARTHQUAKES AT WEASISI, TANNA, NEW HEBRIDES, DURING 1893.

(Reported by Rev. W. Gray.

Date.	Place.	Time (Local).	Apparent Direction.	Apparent Duration.	Effects.—Remarks.	Intensity (Rossi-Forel Scale).
Jan. 19	Weasisi	5·10 a.m.	...	...	Slight, gentle, rocking motion; woke us out of sleep	V.
„ 25	„	1·20 p.m.	...	..	Sharp; shook house	III. to IV.
Feb. 4	„	5·23 p.m.	From S.E.	5 secs.	Shook doors; table quivered	IV.
„ 13	„	4·30 p.m.	S. to N.	3 secs.	Made house sway and creak	IV.
„ 28	„	10·43 p.m.	..	45 secs.	Very severe; house swayed and shook violently; doors were almost forced open; lamp glasses threatened to fall off	VI.
Mar. 3	„	10·43 p.m.	...	45 secs.	Severe; house swayed and shook violently; a continuous shock	IV. to V.
„ 6	„	2·30 p.m.	...	...	Lifted water in a jug ¼ inch; did not move lamp on a side table close by	IV. to V.
„ 7	„	7·30 a.m.	From N. or N.W.	...	Shook dwelling-house; not felt in church... ...	III. –
„ 9	„	6·43 p.m.	From N.	5 secs.	Slight, double tremor; table quivered	IV.
„ 9	„	8·40 p.m.	...	...	Slight	III. –
„ 10	„	0·20 a.m.	...	5 secs.	Sharp	III. +
April 9		7·15 a.m.	From S.E. ?	2 secs.	Slight; shook bed; rumble before shock	III.
Mar. 13	„	10·3 a.m.	From N.	3 secs.	Sharp; shook house; passed slowly	III. +
„ 19	„	9·28 p.m.	...	...	Slight quiver	II.
May 2	„	8·30 a.m.	N.W. to S.E.	30 secs.	Slight, gentle swaying of everything	III. to IV.
„ 11	„	11·45 p.m.	...	40 secs.	Slight; shook house and small things; heard rumbling before shock	IV.
„ 11	„	After midnight	...	30 secs.	Severe; woke us up; shook things violently ...	V. or VI.
„ 12	„	1·8 p.m.	...	5 secs.	Slight; shook water in a jug	IV.

2.—REPORT OF THE RESEARCH COMMITTEE APPOINTED TO COLLECT EVIDENCE AS TO GLACIAL ACTION IN AUSTRALASIA.

Members of Committee:

Captain Hutton	Mr. G. Sweet
Mr. R. L. Jack	Mr. J. Stirling
Professor Tate	Mr. W. Howchin
Mr. R. M. Johnston	Professor David (Secretary).

SOUTH AUSTRALIA.

By Professor RALPH TATE, Mr. WALTER HOWCHIN, and Professor T. W. E. DAVID.

EVIDENCES OF GLACIATION AT HALLETT'S COVE.

Hallett's Cove is situated on the east coast of St. Vincent's Gulf, about 15 miles S.S.W. from Adelaide.

Extensive traces of glaciation were discovered here by Professor Ralph Tate, in 1877, and were described by him in a course of public lectures delivered in May the same year.*

In 1879 he read a paper on the subject of this discovery.†

In 1888 he communicated a paper on the same subject to the Australasian Association for the Advancement of Science.‡

Mr. C. S. Wilkinson, the late Government Geologist of New South Wales, visited Hallett's Cove in company with Professor Tate in 1887, and quite confirmed the latter's opinion as to the phenomena there observable being certainly referable to ice action.

In March, 1891, Mr. R. L. Jack, the Government Geologist of Queensland, visited the same spot in company with Professor Tate, and came to the conclusion that Professor Tate's observation was correct in every particular; and he inferred from the evidence that the movement of the ice had been from south to north.§

During the meeting of the Australasian Association for the Advancement of Science at Adelaide, in September, 1893, Professor Tate conducted over the ground a party of the members. A discussion arose as to whether the glaciation was Pre-Miocene or Post-Miocene, and in order to thoroughly test the question the Association voted the sum of £20 for making any excavations that might be thought necessary by the Glacial Committee. With a view to carrying out the wishes of the Association the spot was inspected in December, 1894, by Professor Tate, Mr. Walter Howchin, and Professor David.

Mr. W. Reynell, the owner of the property, kindly gave permission for making the excavations, and supplied workmen.

With the help of Mr. L. Birks, of Adelaide University, and of the workmen, the necessary excavations were completed a few days later, and a plan and sections of the locality were prepared by the local members of the Glacial Committee, and the secretary, assisted by Mr. L. Birks. The results are detailed later on in this report.

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* Rep. Austr. Ass. Advt. Sci., vol. v., 1893, p. 31.
† Trans. Roy. Soc. S. Austr., vol. ii., p. lxiv.
‡ Rep. Austr. Ass. Advt. Sci., vol. i., 1889, p. 231.
§ Geology and Palæontology of Queensland and New Guinea. By R. L. Jack and Robert Etheridge, junr., p. 619. By Authority: Brisbane, 1892.

As regards the general physical and geological features of the neighbourhood of Hallett's Cove, it may be stated that the country is undulating and hilly at this spot, where a low spur from the Mount Lofty Range trends westerly to the sea coast, and so forms the boundary on the south of the Adelaide Plains. The latter consist of alluvial deposits of Recent and Pleistocene age, resting on Marine Tertiary beds.

The spur consists of Archæan strata of vast thickness, and terminates seawards in rocky cliffs from 50 to 100 feet in height. At Hallett's Cove a terrace of Tertiary rock rises from 120 to 160 feet above the sea. This extends inland for about one-quarter of a mile in an east and west direction, and for over three-quarters of a mile north and south, its trend being approximately parallel with that of the coast. Almost co-extensive with the Tertiary strata are the Glacial Beds, both they and the Tertiaries reposing in a valley or trough of erosion in the Archæan rocks. Northwards the trough appears to end in a *cul-de-sac*. Its boundary on the south has not yet been accurately defined. Where the Glacial Beds have been recently denuded away, at the edge of the sea-cliffs, a striated pavement of Archæan rock is invariably exposed. This can be traced for about half a mile to the north of Black Point, and for about a mile and a-half to the south. Seawards its continuity has been interrupted by the shelf notched in it by the erosive action of the ocean; but it is evident from the section to the south of Black Point that it continues below sea-level, the trough in the Archæan rock above referred to trending seawards, and its bottom lying below the level of low tide between Black Point and the mouth of the Field River. Although the strip of glaciated pavement, at present exposed, is only from a few feet to a few yards in width, it is evident that it would be found everywhere to underlie the Glacial Beds, and, therefore, to extend inland from the face of the cliffs for about a quarter of a mile.

The geological formations represented at Hallett's Cove are briefly as follows:—

(1.) *Archæan* (*Pre-Cambrian*).—The local rocks of this age consist of indurated purplish red clay shales with greenish bands, beds of hard gray quartzite, and occasional thin layers of siliceous limestone.

At one spot in Hallett's Cove the purple shales contain numerous pebbles of gneissic granite, black quartzite, &c.

The bedding planes are regular and well marked, and occasionally, as at the quarry about five miles from Hallett's Cove, on the road towards Adelaide, the Archæan rocks, consisting of micaceous mudstones, are finely laminated. Cleavage and joints are developed in places, but not to such an extent as to obscure the bedding.

For some distance to the north and south of Black Point a well-marked anticlinal axis runs through the Archæan rocks, its trend being S. 21° W., and northwards it bends to N. 31° E. The prevalent dip of the Archæans is W. 10° to 20° N., at from 40° to 78°.

Wherever their surface has been freshly exposed, through the removal by denudation of the overlying Glacial Beds, the Archæan rocks are seen to have been strongly glaciated, the rocks having been ground down, polished, striated, and grooved. The general trend of the grooves is nearly north and south, the southern end being the *stoss-seite.* In places the direction of grooving swings around to from S.E. to N.W., the probable reason for this being the opposition offered to the passage of the ice northwards by the closing in of the trough above referred to at its northern end, so that the ice was compelled to escape over the west edge of the trough (which is low, the east edge being high); and there being already a northerly component in the ice movement, the resultant movement, just at this spot, was north-westerly.

(2.) *Glacial Beds.*—The junction of the Glacial Beds with the Archæan rocks is strongly unconformable, as shown on sections A to B, and B to C, the Glacial Beds being almost horizontal, whereas the Archæan strata dip at about 66°. At a point about twenty-five chains S.S.W. from the northern extremity of the shore line, as shown on the plan accompanying this report, a slight contemporaneous crumpling of the strata is observable, due possibly to the grounding of floating ice. The thickness of the Glacial Beds varies from 23 feet to over 100 feet. They attain an altitude of a little over 100 feet, and descend probably to a considerable depth below low-water level.

The Glacial Beds are composed, in their upper position, of tough reddish-brown clay shales, alternating with soft yellowish sandstones, and passing downwards into a jointed mudstone with glaciated boulders, and occasional lenticular patches of fine to coarse calcareous conglomerate.

The upper portion of this formation is well stratified, and even laminated, but bedding is less distinct in the lower portion. The groundmass of the latter is chiefly a dark grey mudstone passing into argillaceous sandstone. The rock is fairly coherent, though less indurated than the Glacial Beds at Bacchus Marsh. The calcareous grits and conglomerates effervesce briskly in hydrochloric acid. At the first gully to the north of Black Point the Glacial Beds dip easterly at a low angle off the glaciated surface of the Archæan rock. The outcrop on the beach, between high and low water marks, shows the beds to be jointed in directions between S. 30° to 50° E., and N. 30° to 50° W., and S. 30° W. and N. 30° E. Ice-scratched boulders and pebbles are sparingly distributed through the higher portion of this deposit, where it immediately underlies the Miocene strata, but become more numerous at the lower levels, especially at the outcrop on the beach. In the lower portions of the Glacial Beds the boulders constitute from about one-tenth to about one-quarter of the whole bulk of the rock. They vary in size from pebbles an inch or so in diameter up to blocks weighing seven or eight tons, those which are between 1 inch and 1 foot in diameter being most common. In shape they are flattened oval or irregularly rounded or faceted. No absolutely angular fragments of rock were observed. Nearly all the quartz grains in the groundmass are intensely waterworn. The rounded boulders are for the most part scored with sets of parallel cuts from one-sixteenth to one-quarter of an inch in depth, and are covered with strongly-marked striæ in parallel sets intersecting one another at various angles. Many of the harder boulders exhibit a dull polish. Most of them have their broadest surfaces parallel with the planes of bedding in the groundmass, but some of them are imbedded with their longer axes nearly vertical.

They are composed for the most part of quartzite and fragments of reddish purple sandy shale, weathering greenish grey, both varieties being precisely similar to the dominant local types of Archæan rocks. There can be little doubt that the bulk of the boulders and of the material composing the Glacial Beds, especially the reddish clay shales intercalated with the boulder beds, is of local origin, and derived from the crushing and partial trituration of the neighbouring Archæan rocks. Associated, however, with the blocks of purely local origin are various foreign rocks, true erratics, the parent rocks of which "do not occur *in situ* nearer than the Gorge at Normanville, about thirty miles to the south. In all seventeen distinct varieties of rock, chiefly metamorphic, and foreign to the immediate neighbourhood, have been collected."*

Conspicuous among the foreign rocks is a variety of very coarsely crystalline red granite, containing crystals of orthoclase felspar over 2 inches in diameter. A rounded block of this, measuring 8 feet by 6½ feet by 4 feet, is observable on the beach a short distance to the south of the mouth of Field River, which empties into Hallett's Cove. This has probably been derived from Port Victor or Port Elliott, about forty miles to the south of Hallett's Cove.

No fossils have as yet been found in the Glacial Beds. In the opinion, however, of two of us (Professor David and W. Howchin as the result of personal investigation of both fields), it is thought to be possible, on lithological evidence, that the beds are homotaxial with the Bacchus Marsh Beds of Victoria, and are therefore of Permo-Carboniferous or, perhaps, of Triassic Age. It is, however, possible that they may belong to any date intermediate between that of Miocene and late Palæozoic, as, for example, Cretaceous.

A comparison of the striated pavements of Hallett's Cove with those of Bacchus Marsh and Derrinal in Victoria suggests that the first-mentioned appears to be fresher and newer than the two last, and certainly the material of the Glacial Beds at Hallett's Cove is generally less indurated than that of Bacchus Marsh and Derrinal, a fact which may point to the same conclusion. On the other hand, in places, the Bacchus Marsh and Hallett's Cove beds are so like one another as to be undistinguishable in hand specimens.

(3.) *Arenaceous Limestone Passing Downwards into Soft Yellowish Sandstone.*—The limestone contains an abundant marine fauna, determined as Miocene by Professor Ralph Tate. The following are the most characteristic fossils :—

Trophon anceps, Tate
Trophon approximans, Tate
Triton sexcostatus, Tate
Cominella Clelandi, Tate
Ancillaria oryeta, Tate
Marginella hordeacea, Tate
Heligmope Dennanti, Tate
Natica subvarians, Tate
Hipponyx australis, Lamk.
Ostrea arenicola, Tate
Placunanomia Ione, Gray
Spondylus arenicola, *nom. emend.*
(*Pecten spondyloides*, Tate)
Pinna semicostata, Tate
Lithodomus brevis, Tate
Lucina nuciformis, Tate
Tellina lata, Q. and G.
Laganum platymodes, Tate
Plesiastræa Vincenti, T. Wds.
Orbitolites complanatus, Lamk.

* Rep. Austr. Ass. Advt. Sci., vol. i., p. 232. Glacial Phenomena in South Australia. By Professor Ralph Tate.

The arenaceous limestone, which passes in places into a calcareous sandstone, has a thickness of from 2 to 3 feet, and is very persistent. It is whitish-grey in colour, and, owing to its hardness, forms a well-marked feature wherever it outcrops. In places, as at the southern end of "The Amphitheatre," (*vide* plan) it passes downwards into a thickness of from 10 to 15 feet of soft yellowish sandstone.

Blocks of rock similar to those in the Glacial Beds are found at intervals embedded in the Miocene limestone, as at the points marked D, E, and F on the plan, a band of them usually marking the base of the Miocene formation. At the point marked G, an erratic of Port Victor granite appears to be partially embedded in the upper surface of the Miocene limestone. It measures 3 feet by 2 feet, by at least 1 foot in height.

At the point marked H, at "The Amphitheatre," a mass of Archæan rock, measuring 12 feet by 3½ feet, by at least 1 foot, has weathered out from the Miocene limestone, and, having been partly undermined near the edge of a small waterfall, has become cracked through by its own weight, and the greater portion has slipped down to a lower level, while the remainder is still firmly embedded in the Miocene limestone. The junction line between the Miocene strata and the Glacial Beds is seen in places to be an eroded one. The area of the Miocene limestones and calcareous sandstones, shown on the plan, is about 100 acres. They extend inland for about from 20 to 25 chains, and attain a level of 108 feet above high water at the point marked I on plan, while they are 87 feet at the point marked J, 58 chains south from I.

(4.) *Clays overlying the Miocene Limestone.*—These weather olive-brown to reddish-brown. No fossils have as yet been found in them. Their thickness is about 60 feet. They are probably of Miocene age, though possibly later.

(5.) *Nodular Travertine.*—About 3 to 4 feet thick, capping the preceding clays. Rarely have been found land-shells of recent species enclosed in the travertine.

(6.) *Blown Sand and Beach Sand and Gravel.*—This is of recent age, and rests successively on each of the preceding formations.

SUMMARY.

The formations, ranged in ascending order, are therefore as follows:—

(1.) *Archæan.*—Reddish purple shales and quartzites, &c. Thickness, several thousands of feet (strong unconformability).

(2.) *Permo-Carboniferous.*—Shales and mudstones, &c., with glaciated boulders and large erratics, resting on a glaciated pavement of the Archæan rock. Thickness, over 100 feet (slight erosion).

(3.) *Miocene Marine Sandy Limestone.*—Thickness, 3 feet.

(4.) *Miocene.*—Clays. Thickness, 60 feet.

(5.) *Recent.*—Nodular travertine. Thickness, 3 to 4 feet.

(6.) *Recent.*—Blown sand and beach sand and gravel.

The following conclusions may be provisionally deduced :—

(1.) The formation of the Glacial Beds, and the glaciation of the pavement upon which they rest, belong to the same epoch.

(2.) The carry of the erratics and the grooving of the pavements prove that the ice travelled from south to north.

(3.) The Glacial Beds are capped by marine sandy limestones of Miocene age, the junction line being an eroded one. The glaciation was therefore Pre-Miocene.

(4.) The glaciation of Hallett's Cove may perhaps be correlated with that of Bacchus Marsh and of Derrinal, in Victoria, and with that of the Inman Valley, near Port Victor, South Australia. It may, however, be referable to any geological age intermediate between that of the beginning of the Miocene and the close of the Palæozoic. If the comparatively fresh appearance of the Glacial Beds and their approximate horizontality be any criterion, it is highly improbable that they are older than late Palæozoic.

3.—ABBREVIATED NAMES FOR CERTAIN CRYSTAL FORMS.

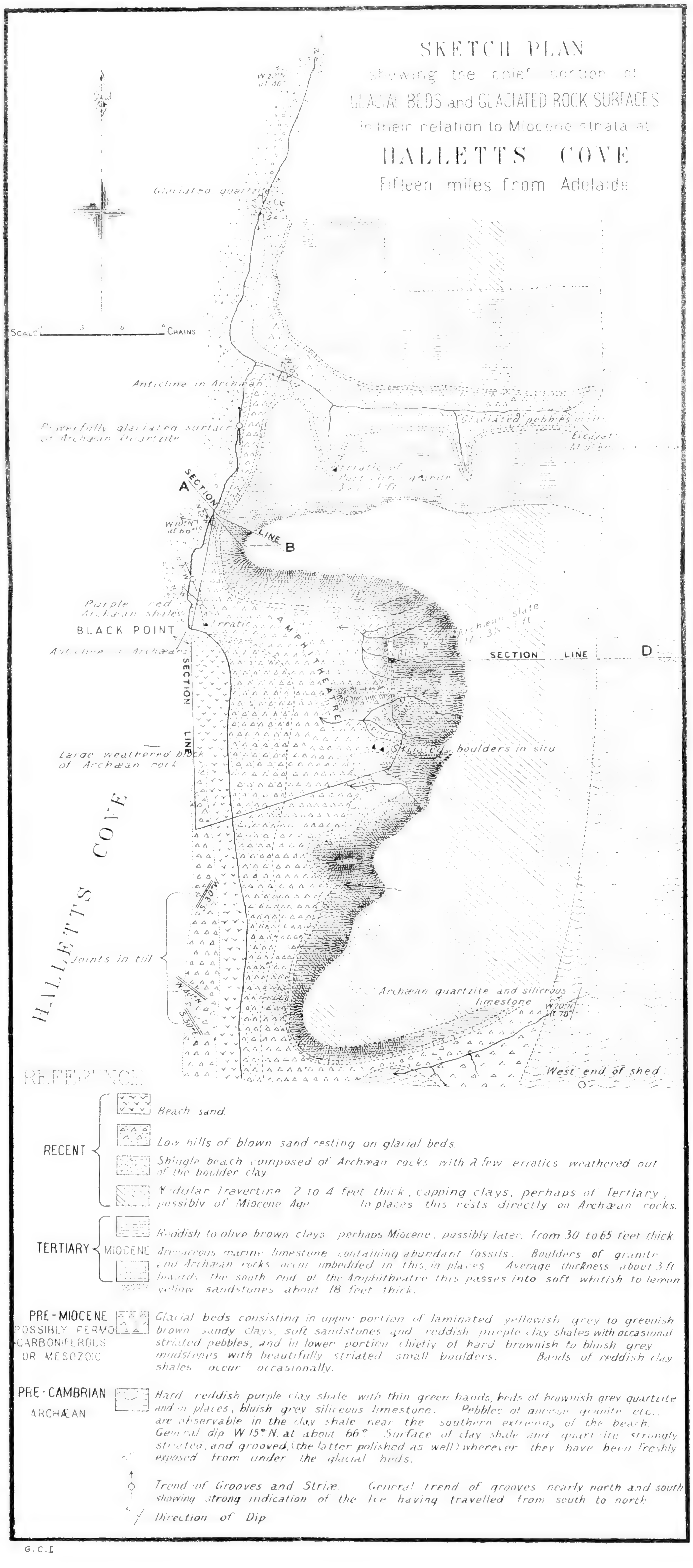
By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, N.S.W.

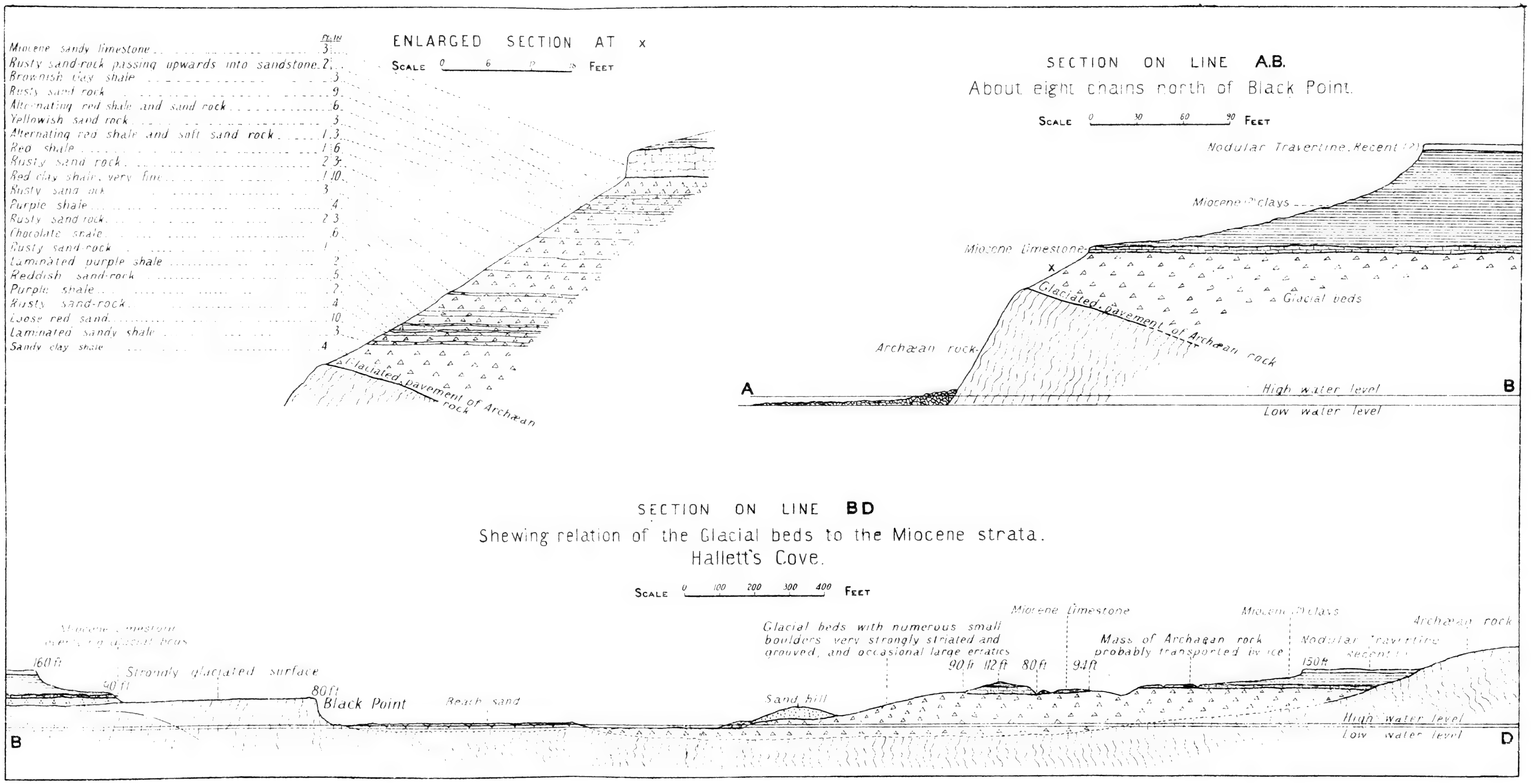
When the names of crystals have to be used constantly, as in lecturing upon or speaking about crystals and minerals, the waste of time involved by the present sesquipedalian names is a very serious matter, and it appears to me that it is desirable to shorten them somewhat. I therefore venture to propose the following curtailed names for certain crystals to be used ordinarily, although not always, in place of the descriptive terms now in use.

The third column shows the number of letters saved in each case.

In every instance sufficient of the roots of the full name have been retained to indicate the source and meaning of the proposed abbreviated terms.

Name.	Abbreviated Name.	Saving of Letters.
Octahedron	Octron	4
Hexahedron	Hexron	4
Rhombic dodecahedron	Rhododecron	8
Triakis octahedron	Trioctron	8
Icositetrahedron	Icotreton or Icositetron... ...	7 or 5
Tetrakishexahedron	Tetrahexron	7
Hexakisoctahedron	Hexakisron or Hexoctron ...	7 or 8
Tetrahedron	Tetron	7
Trigonal-dodecahedron	Tridodecron	9
Deltoid-dodecahedron	Deldodecron	8
Hexakistetrahedron	Hexatetron	8
Pentagonal-dodecahedron ...	Pentron or Pentadodecron ...	15 or 9
Trapezohedron	Trapezron	4
Tetragonal Pyramid	Tetramid	9
Ditetragonal Pyramid	Ditetramid...	9
Tetragonal Prism	Tetrism	8
Ditetragonal Prism	Ditetrism	8
Sphenoid	Sphenoid	0
Scalenohedron	Scalenron	4
Hexagonal Pyramid	Hexamid	9
Dihexagonal Pyramid	Dihexamid...	9
Hexagonal Prism	Hexism	8
Dihexagonal Prism	Dihexism	8
Rhombohedron	Rhombron	4


SKETCH PLAN
showing the chief portion of
GLACIAL BEDS and GLACIATED ROCK SURFACES
in their relation to Miocene strata at
HALLETTS COVE
Fifteen miles from Adelaide
SCALE 3 6 CHAINS
Glaciated quartzite
Anticline in Archæan
Powerfully glaciated surface of Archæan Quartzite
Glaciated pebbles
SECTION LINE
A
B
D
Purple red Archæan shales
BLACK POINT
Anticline in Archæan
Erratic
AMPHITHEATRE
Archæan slate
Large weathered block of Archæan rock
Striated boulders in situ
HALLETTS COVE
Joints in till
Archæan quartzite and siliceous limestone
West end of shed
REFERENCE
RECENT
Beach sand.
Low hills of blown sand resting on glacial beds.
Shingle beach composed of Archæan rocks with a few erratics weathered out of the boulder clay.
Nodular Travertine 2 to 4 feet thick, capping clays, perhaps of Tertiary, possibly of Miocene Age. In places this rests directly on Archæan rocks.
TERTIARY
MIOCENE
Reddish to olive brown clays perhaps Miocene, possibly later. From 30 to 65 feet thick.
Arenaceous marine limestone containing abundant fossils. Boulders of granite and Archæan rocks occur imbedded in this in places. Average thickness about 3 ft. Towards the south end of the Amphitheatre this passes into soft whitish to lemon yellow sandstones about 18 feet thick.
PRE-MIOCENE
POSSIBLY PERMO-CARBONIFEROUS OR MESOZOIC
Glacial beds consisting in upper portion of laminated yellowish grey to greenish brown sandy clays, soft sandstones and reddish purple clay shales with occasional striated pebbles, and in lower portion chiefly of hard brownish to bluish grey mudstones with beautifully striated small boulders. Bands of reddish clay shales occur occasionally.
PRE-CAMBRIAN
ARCHÆAN
Hard reddish purple clay shale with thin green bands, beds of brownish grey quartzite and in places, bluish grey siliceous limestone. Pebbles of ancient granite etc., are observable in the clay shale near the southern extremity of the beach. General dip W.15°N. at about 66°. Surface of clay shale and quartzite strongly striated, and grooved, (the latter polished as well) wherever they have been freshly exposed from under the glacial beds.
Trend of Grooves and Striæ. General trend of grooves nearly north and south showing strong indication of the Ice having travelled from south to north.
Direction of Dip
G.C.I.

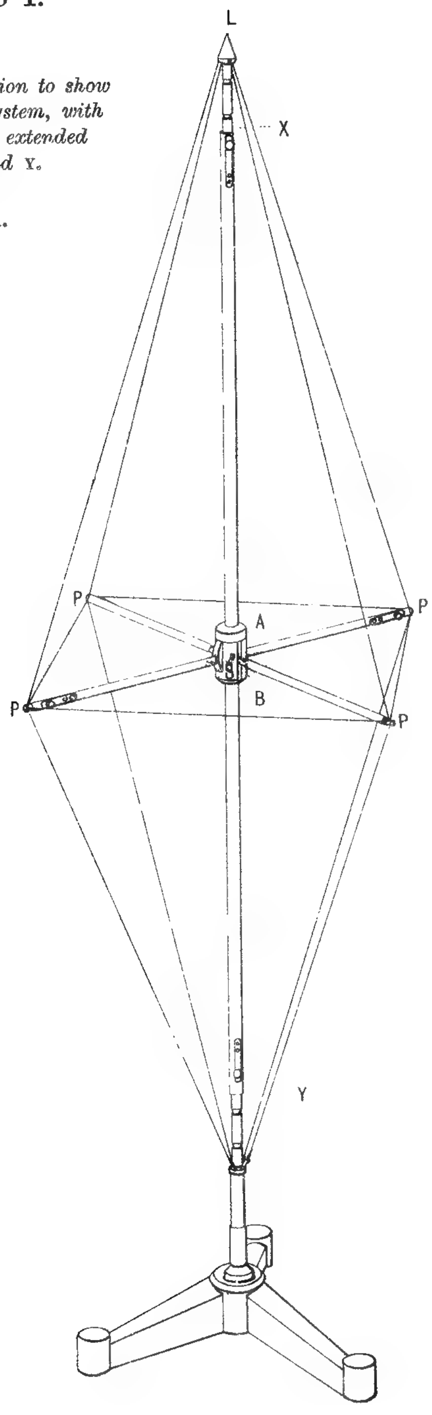

ENLARGED SECTION AT x
SCALE 0 6 12 18 FEET
FT. IN
Miocene sandy limestone 3
Rusty sand-rock passing upwards into sandstone 2
Brownish clay shale 3
Rusty sand rock 9
Alternating red shale and sand rock 6
Yellowish sand rock 3
Alternating red shale and soft sand rock 1 3
Red shale 1 6
Rusty sand rock 2 3
Red clay shale, very fine 1 10
Rusty sand rock 3
Purple shale 4
Rusty sand rock 2 3
Chocolate shale 6
Rusty sand-rock 1
Laminated purple shale 2
Reddish sand-rock 5
Purple shale 7
Rusty sand-rock 4
Loose red sand 10
Laminated sandy shale 3
Sandy clay shale 4
Glaciated pavement of Archæan rock
SECTION ON LINE A.B.
About eight chains north of Black Point.
SCALE 0 30 60 90 FEET
Nodular Travertine, Recent (?)
Miocene (?) clays
Miocene Limestone
x
Glacial beds
Glaciated pavement of Archæan rock
Archæan rock
A
B
High water level
Low water level
SECTION ON LINE BD
Shewing relation of the Glacial beds to the Miocene strata.
Hallett's Cove.
SCALE 0 100 200 300 400 FEET
160 ft
40 ft
Strongly glaciated surface
80 ft
Black Point
Beach sand
Sand hill
Glacial beds with numerous small boulders very strongly striated and grooved, and occasional large erratics
90 ft 112 ft 80 ft
Miocene Limestone
94 ft
Mass of Archaean rock probably transported by ice
Miocene (?) clays
150 ft
Archæan rock
High water level
Low water level
B
D

G.C.H.

Model No 1.

Model in position to show Tetragonal system, with vertical axis extended at x *and* y.

Fig. 1.



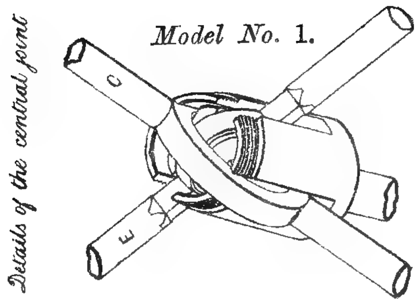

Details of the central joint
Model No. 1.
C
E

Fig. 2.

Fig. 3

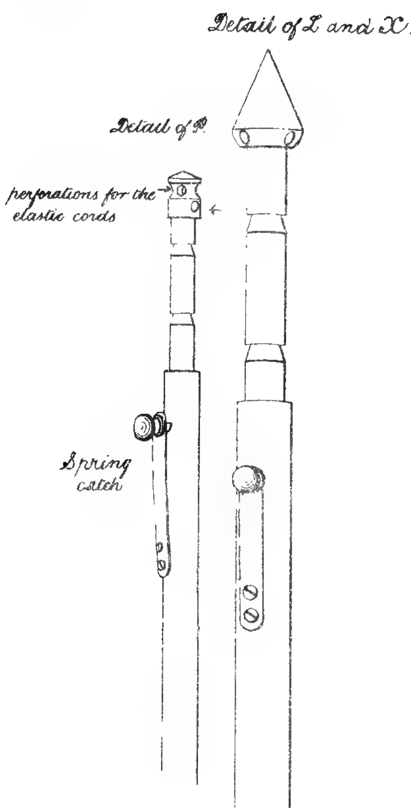

Detail of L and X.
Detail of P.
perforations for the elastic cords
Spring catch

Fig. 4.

Plate of details of intersection of axes in Model No. 1.

The sliding button J *and washer* K *are fastened on either side of* E *by means of screw* F.

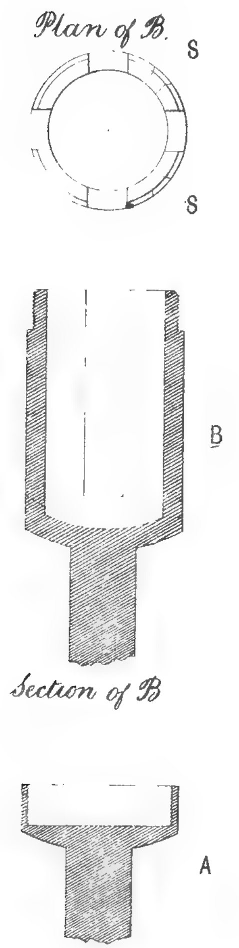
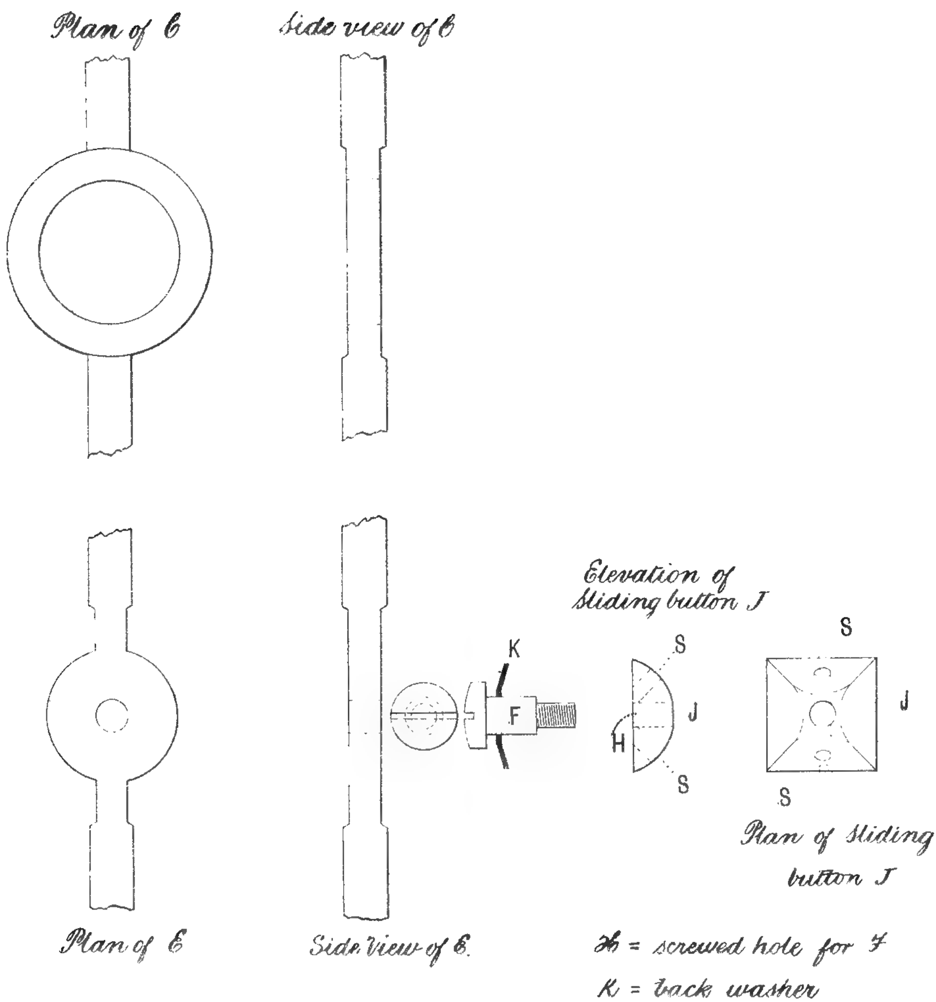


Fig. 4.

Plate of details of intersection of axes in Model No. 1.

The sliding button J *and washer* K *are fastened on either side of* E *by means of screw* F.



Model No 1.

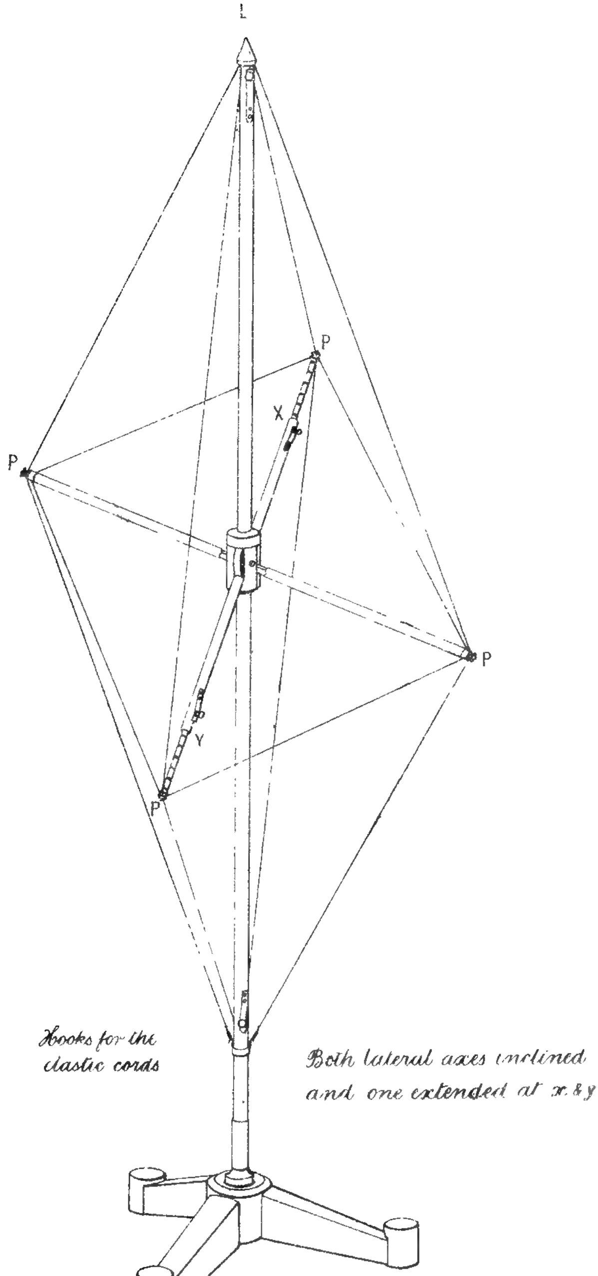


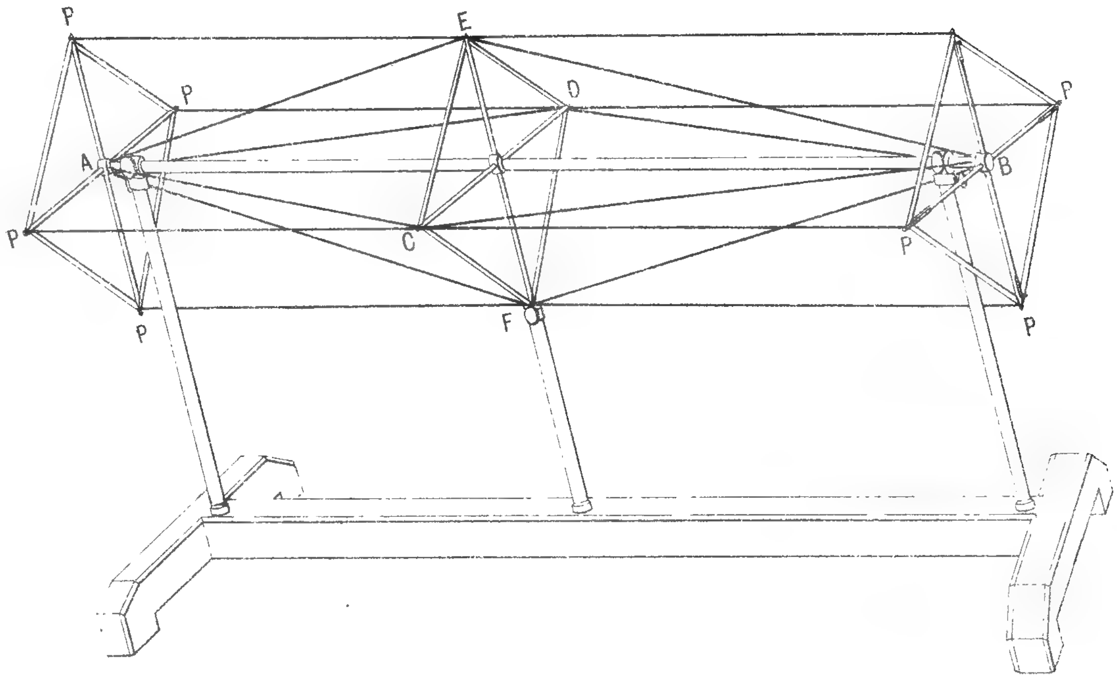
Fig. 5.

With both horizontal axes inclined and one extended.

Fig. 6

Model to show the relationship of the domes and terminal pinacoids to the macro and brachy pyramids.

The three axes AB, CD, *and* EF *can all be extended by equal increments as in the case of Model No. 1.*



L 15

4.—MODELS TO SHOW THE AXES OF CRYSTALS.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, N.S.W.

These models have been used by me for teaching purposes since 1875, and have been shown at the International Exhibitions of Philadelphia, London, Melbourne, and Chicago; but, up to the present, no account has been published of them.

The two models show the relationship of the axes in the tetragonal, rhombic, oblique, and doubly oblique systems of Crystals.

The edges of the Crystals are represented by elastic cords, so as to permit of the extension of the axes.

Model No. 1 shows the relationship of the axes in the tetragonal, rhombic, oblique, and doubly oblique systems. Plate, Fig. 1.

- (*a*) By extending the vertical axis, acute tetragonal pyramids are obtained. Fig. 2 shows the device for the axial joints.
- (*b*) By extending one or both of the horizontal axes, the rhombic system is shown. Fig. 3 shows details of L and X.
- (*c*) The oblique or monoclinic system is obtained by inclining one axis. Fig. 4 gives details of intersection of axes.
- (*d*) The doubly oblique or anorthic system is shown by inclining two axes. Fig. 5.
- (*e*) Each axis can be extended by regular increments independently of the others.

All three of the axes can be extended to represent various pyramids; the different forms of brachy and macro pyramids are shown by extending the lateral axes.

Model No. 2 shows how the domes and horizontal prisms are produced from the pyramids by extending the axes to infinity. Fig 6.

All of the axes can be extended by regular increments, as in the first model.

5.—THE GLACIAL DEPOSITS OF BACCHUS MARSH.

By GRAHAM OFFICER, B.Sc., and LEWIS BALFOUR, B.A.

At the last meeting of this Association, held at Adelaide, a paper was read by Mr. G. Sweet, prepared by himself and Mr. Brittlebank, on the glacial deposits of Bacchus Marsh, containing statements to which, through our unavoidable absence, we regret we were unable to reply at the time. As their paper is in great part a criticism of a former one by us, read before the Royal Society of Victoria—and as Messrs. Sweet and Brittlebank chose to read their paper before this Association—we feel that we cannot, in duty to ourselves, allow this present meeting of the Association to pass without a justification of our position.

The first point that we would direct attention to is that Messrs. Sweet and Brittlebank, by implication at least, if not directly, would have it appear that we had trespassed on their prior claim to the working of the district, as surely must appear to anyone who will read the first few paragraphs of their paper. As such an act, we consider, would be manifestly discourteous on our part, we cannot pass this by without a reply.

In the first place we desire to state that when we first visited the district in June, 1892, we had not the slightest idea that anyone else was working in the same field, the latest reference to the glacial beds that we knew of being that of Mr. Dunn. Subsequently on our second visit we were introduced to Mr. Brittlebank, and learned for the first time that Mr. Sweet had been in the district before us. Neither of us were at that time acquainted with Mr. Sweet; and Mr. Brittlebank, though we informed him of the object of our visit, never gave us the slightest hint that they were working together with a view to publishing the results of their observations.

Messrs. Sweet and Brittlebank's prior claim would appear to be based on the fact that a few members of the Field Naturalists' Club of Victoria, including Mr. Sweet, made one of their periodical excursions to the locality in October, 1891, under the leadership of Mr. A. J. Campbell, Mr. Brittlebank acting as guide. Messrs. Sweet and Brittlebank say:—"We then commenced and have since continued working together, with the intention of making the results of our investigations known at as early a date as possible, and as much was hinted by the leader of the excursion above referred to in his report to the Field Naturalists' Club." On referring to the report in question we find the "hint" referred to consists of the words:—"Some instructive geological notes bearing upon the locality, and remarks upon impressions of leaves and fruits will be *probably* offered by Mr. Sweet on another occasion." Mr. Sweet also exhibited, at a subsequent meeting of the club, "pebbles, *probably* glaciated, from Myrniong." [The italics are ours.]

Surely no one would seriously imagine that a brief reference, in the report of an excursion of a Naturalists' Society, to the probability of future geological notes being submitted, which are not expressly stated as intended to relate to the glacial beds, and the exhibition of a probably glaciated stone, would establish a prior claim to the working of the glacial geology of the district. If, as they state, they were working together with the intention of publishing their results as soon as possible, it is indeed a strange and unaccountable circumstance that Mr. Brittlebank, although we saw him frequently, and although considerable correspondence passed between him and one of the writers, never gave us the slightest hint that such was the case. On the contrary, he appeared to be quite anxious that we should read our paper as soon as possible; and, some little time after our paper had been read, he agreed to collaborate with ourselves in working at the geology of the district. It was not till the following February that one of the writers, who was then in Tasmania, received a letter from Mr. Brittlebank stating that someone was going to publish the latter's notes. We afterwards learned that he and Mr. Sweet intended working together, but this was not until seven months had elapsed since our paper was read before the Royal Society of Victoria.

From these facts, we cannot think that we have been in the very least to blame in trespassing on a prior claim. We indeed acknowledge frankly that Mr. Brittlebank had long before recognised the glacial character of the rocks under discussion; but, as will have been observed, he had given us no intimation of any desire to publish anything on the subject.

A great deal of Messrs. Sweet and Brittlebank's paper is occupied in criticising our former contention that there was a Tertiary boulder-clay, as well as the much older one. It is true that we did originally maintain the presence of a Tertiary boulder-clay. Subsequently, however, we became convinced of our error—which had arisen through our mistaking redistributed glacial material for the rock *in situ*—and we hastened to correct it in a second note read before the Royal Society of Victoria in June, 1893, in which we gave our reasons for altering our opinion. Mr. Sweet was present at this meeting, and took part in the discussion. Under these circumstances it appears to us that Messrs. Sweet and Brittlebank's criticisms were wholly unnecessary.

6.—THE GLACIAL GEOLOGY OF COIMADAI.

By GRAHAM OFFICER, B.Sc.; LEWIS BALFOUR, B.A.; and EVELYN G. HOGG, M.A.

The principal locality referred to in the following paper is that of Coimadai, in the parish of Merrimu, and included between the Lerderderg Ranges on the west, Djerriwarrah on the east, the Lerderderg River on the south, and running north from the Lerderderg about six miles. This country lies to the east and north-east of that described by Messrs. Sweet and Brittlebank in a paper read before the Association at its Adelaide meeting.

We became first acquainted with Coimadai about eighteen months ago, when we made certain discoveries that decided us to commence a systematic investigation of the geology of the district. This we have since been attempting to carry out.

In the present paper we shall deal only with the glacial deposits developed in the district, and shall refer to other deposits in so far only as they bear on the stratigraphical relationships of the former.

PHYSICAL FEATURES.

The country is traversed by the Lerderderg River and its tributaries, the Goodman's, Pyrete, and Djerriwarrah Creeks, all of which flow in a southerly direction. Back and Basin Creeks flow respectively into Goodman's and Pyrete Creeks. The area of this district is about 36 square miles, of which the glacial beds appearing at the surface occupy a small proportion. The interest in this locality lies to a large extent in the remarkable sections exposed on certain of the streams traversing the country.

The physical aspect of the country presents certain well-marked features dependent on its geological structure. The formations present in the district are—

Lower Silurian,
Glacial Series,
Tertiary,
Basalt,
Recent.

The Silurian are the lowest rocks in the district, and form the usual rough wooded hills. The glacial beds form rounded hills of considerable value from an agricultural point of view. This rounded appearance would seem to be a characteristic one, precisely the same features marking the glacial beds at Derrinal. The Tertiaries (?) developed consist of—

(1.) Magnesian limestone, probably lacustrine.

(2.) Ferruginous conglomerates, pipeclays, and gravels.

Beyond noting the fact that these overlie the glacial beds unconformably, we do not propose to deal further with them at present. The country lying between Goodman's and Pyrete Creeks is occupied to a great extent by a long narrow strip of basalt, which has flowed from Mount Bullengarook lying to the north. It overlies the above-mentioned tertiary beds.

The glacial beds are best studied along Pyrete, Goodman's, and the Back Creeks, and the Lerderderg River. From the sections there exposed, we find that the beds composing the glacial series consist of three well-marked classes of rock:—

(1.) Stratified mudstones.

(2.) Glacial conglomerates (for the want of a better term).

(3.) Stratified sandstones and freestones.

(7.) Stratified Mudstones.

These, found along the above-mentioned streams, consist of a hard tenacious clay, varying in colour, pink, purple, blue, and yellow being the prevailing tints. They are regularly stratified, and occasionally finely laminated. Their glacial character is at once attested by the number of scored and scratched stones and boulders, varying from mere pebbles to hugh rock-masses weighing tons, contained in them. As regards arrangement, the greater bulk of the stones and boulders are scattered irregularly through the matrix, but in places regular beds or bands of these scored stones can be seen, as if they had all been laid down on a level floor—*e.g.*, sections near Elam's. In these bands waterworn pebbles are usually abundant. Here and there throughout the mudstones, irregular "nests" and patches of waterworn conglomerate and coarse angular grit occur.

These stratified mudstones are the lowest beds of the series exposed in this district. They are well shown on Goodman's Creek, about 1½ miles from the mouth, opposite R. Elam's farm. Here they consist of stratified blue clays, and the boulders contained in this matrix are numerous and large, and generally exceedingly well scored. One granite boulder lying in the bed of the creek, is well scored and flattened, and measures 8 ft. 3 in. × 4 ft. 5 in. × 1 ft. 10 in., and Mr. Elam told us that he had removed fully half of it, so that originally it was about 17 feet long. Another boulder of granite here is about 10 feet in diameter; another, of hard sandstone, measures 6 ft. 6 in. × 6 ft. × 3 ft. 6 in.; while one of quartzite is 4 ft. 6 in. × 4 ft. × 3 ft. 6 in. Similar blue clays appear also on the Lerderderg.

(2.) Conglomerates.

The next type of rock that we distinguish is a conglomerate, usually of a purple colour, though generally stained with yellow and red. This class of rock does not show stratification nearly so well as the first class, and very often appears to be quite unstratified. It likewise contains numerous scored and glaciated pebbles and boulders scattered irregularly through the matrix. Well-stratified bands occur here and there, as well as irregular patches of grit and conglomerate. Fine sections of this are to be seen on Goodman's Creek, one mile above Elam's, on the Lerderderg River, and on the Pyrete Creek. On Goodman's Creek this conglomerate lies over the stratified clays.

(3.) Stratified Sandstones and Freestones.

The third class of beds are the sandstones. They are developed in this district only between the Lerderderg and Goodman's Creek. We have not observed any on the side of the Pyrete Creek. They are quite similar in appearance to the Bacchus Marsh sandstones, and have been quarried for building stone. They contain intercalated beds of mudstone and conglomerate, and are often highly calcareous, and generally contain magnesia. Here and there large boulders of granite and other material are met with in these sandstones, one such measuring 4 feet in diameter.

THICKNESS.

The thickness of rock exposed in the Coimadai district is not nearly so great as on the Korkuperrimul Creek, and given by Messrs. Sweet and Brittlebank as 4,000 feet at least. The sandstones on Goodman's Creek are probably not more than 100 feet thick. They probably lie below the Bald Hill sandstones.

The average angle of dip is much smaller in Goodman's and Pyrete Creeks than on the Korkuperrimul, the beds showing comparatively little disturbance. Faults of a few feet are not uncommon, but so far we have not detected any of large size. The average angle of dip along Goodman's Creek is not more than from 12° to 15°. Near the south end of the creek, on the Lerderderg River, the beds are dipping about 20° to 25° S., 20° E., corresponding to the general dip of the beds in the region treated of by Messrs. Sweet and Brittlebank. North of this, between this point and the termination of the beds against the Silurian, two anticlines are developed, which are probably of only minor importance. Measuring along one leg of one of these anticlines, taking an average angle of 12°, we get a thickness of about 1,200 feet; and adding the thickness of the beds not shown in this anticline we arrive at a total thickness of 1,860 feet.

The glacial beds are much jointed, but two sets can be distinguished, the most constant having a direction approximately E. and W., while another set has a general N. and S. direction. Dykes are numerous, and seem to have followed the direction of the E. and W. joint planes. Sections of these have been prepared for microscopic examination.

ROCK MATERIAL.

This is very varied. Much is similar to that found in the Bacchus Marsh district, but we found specimens that we do not remember having seen elsewhere. Sections of much of this material have been prepared for microscopic examination, and the results will be published in a future paper. Granites are very abundant, the largest boulders being of this material. Quartz, quartzites, quartz-porphyry, sandstones, jasper, lydianstone, gneiss, slates, conglomerate also occur in the drift of this district. The quartzites as a rule exhibit the best scorings and groovings.

SCORED ROCK SURFACES.

The scored rock surfaces are perhaps the most striking feature of the Coimadai district. In August, 1893, we made our first discovery (in this locality) of these really remarkable phenomena on the Pyrete Creek, about a mile below Coimadai. Since then we have found the scored surfaces at numerous other points in the locality. But we shall in this present paper refer only to the best examples, leaving a more detailed description for a future paper, when our completed map of the district will be published. At several points along the Pyrete Creek sections are exposed, showing the junction of the glacial beds with the Silurian, and it is at these places that the latter exhibit all the features of typical *roches moutonnées.*

An exceedingly good example is to be seen on the Pyrete Creek about 1½ miles below the Coimadai township. The stream has here removed the glacial drift from the underlying Silurian, which at this spot consists of very hard sandstone, and presents the rounded and smoothed appearance of typically glaciated rocks. These rocks extend over about 70 yards along the left bank of the stream; the middle part, however, being concealed by recent alluvium. In addition to the smoothed and rounded appearance very distinct groovings and scorings are to be noticed, and in places patches of the drift are still to be seen adhering to the scored surface. The direction of the grooves and scorings is on the whole a little E. of N.E. As these *roches moutonnées* form two main masses, we have named them the "Pyrete Twins," for convenience in reference.

Several hundred yards in a N.E. direction from these the Silurian again crops out at a higher level, and exhibits a beautifully scored surface. A good deal is covered by turf and soil which could be removed with little trouble. A considerable area of *roche moutonnée* is developed here. Unfortunately portions of it have been broken up to furnish building stone for an adjacent cottage, the owner of which, Mr. Wightman, we have requested not to further disturb this really splendid example of a glaciated surface. This we have named "Wightman's Rock." Both here and in the case of the Pyrete Twins the scorings correspond in direction neither with the strike nor the dip, but lie between the two.

About a mile further down the creek is a section showing the glacial conglomerate, which here looks exceedingly like till, overlying the Silurian. The latter is again well scored and grooved, the direction being about N.E. In a small gully running parallel with the road to Melton, half a mile out of Coimadai, another well-scored surface can be seen, the directions of the scorings there being N. 35° E. Numerous other examples also occur, but the abovementioned are the best. Speaking in general, wherever the contact of the glacial drift with the Silurian can be observed, the latter is almost invariably scored and striated in a manner that could have been done only by glacier or land-ice moving in a direction from S.W. to N.E.

DIRECTION OF ICE FLOW.

The direction of motion of the ice as indicated in the Coimadai district—namely, from S.W. to N.E. approximately—is quite in accord with Mr. Brittlebank's observations in the Bacchus Marsh and Myrniong districts. The direction at Coimadai, however, seems to have been slightly more easterly than in the former localities. This slight difference is, however, of no great moment, as we have reason to believe that it was due to merely local circumstances in the contour of the country.

In these districts traversed by Messrs. Sweet and Brittlebank and ourselves, the scored rock surfaces—*roches moutonnées*—have now been observed over a distance of about fifteen miles, measured across the direction of the ice-flow, and it is not unreasonable to believe that the ice was continuous over this area.

The well known scored rock surfaces at Hallett's Cove, Adelaide, indicate that the ice causing them moved from the south to the north. Mr. Jack satisfied himself that such was the case in 1891, and discussed the possibility of an Antarctic ice-sheet having reached the Australian shores. Up to the present time of writing this paper, the age of the glacial deposits and scored surfaces at Hallett's Cove has not been determined. Professor Tate inclined to the opinion that they were Post-Miocene, but the evidence adduced in support was not conclusive. We have not visited Hallett's Cove, but we are strongly tempted to think that the glacial deposits in South Australia will turn out to be coeval with the Victorian ones. The fact of the ice having moved from south to north is one of the most interesting discoveries in Australian geology, and the honour of first noting it in the Bacchus Marsh district must rest with Mr. Brittlebank.

GENERAL OBSERVATIONS.

We are of opinion that the facts of glacial geology observed by us in this district point conclusively to the action of a sheet of land-ice, which moved in a general north-easterly direction, and probably reached as far north as Derrinal at least, where the motion of the ice-sheet, as shown by Dunn's Rock, is from south to north. That a subsidence of the land surface took place when the ice-sheet had reached its maximum extension seems required to account for the stratified beds already referred to; in fact, there would appear to have been oscillations of level, phenomena similar to which obtained during the Pleistocene Ice Age.

In dealing with the glacial beds of Bacchus Marsh and Coimadai, it must be remembered that the localities in question are probably very distant from the line of farthest extension of the ice-sheet, where the terminal moraine of greatest dimensions would in general be found. If a terminal moraine existed, as it most probably did, traces of it may yet be found underlying the later formations to the north of Derrinal—perhaps considerably to the north.

This absence of terminal moraines may be urged in opposition to the theory of the land-ice-sheet. It should, however, be borne in mind that the magnitude of morainic accumulations depends upon two main factors: First, the quantity of material available for transport; and, secondly, the length of time during which the front of the ice-sheet remains stationary. With respect to the first condition nothing definite can be affirmed, but even supposing that a large supply of material available for morainic purposes did exist, yet, if the ice-front terminated in water of sufficient depth to permit the icebergs to float off to lower latitudes with their accumulated rock-débris, the terminal moraine might be insignificant or even absent

The position of the highlands which formed a gathering-ground for the glaciers is a question of great importance. They lay undoubtedly to the south, and possibly were part of a former great Antarctic continent since submerged. The fact of the northerly motion of this ancient ice-sheet would seem to lend considerable support to the arguments for an "Antarctica," adduced from the geographical distribution of certain plants and animals which have been considerably discussed of late years.

In this connection it is instructive to note the great development of conglomerates of supposed Devonian Age—containing stones at least 2 feet in diameter—occurring in the West Coast Range of Tasmania. The older rocks of Victoria are fine-grained, and must have been laid down for the most part in deep water, while the nature of this conglomerate indicates its former deposition in shallow water, thus pointing to probable highlands to the south of Victoria.

Although the direction of the ice-sheet that first advanced over this country was from the southwards, yet it does not follow that all of the foreign rock-material found in the glacial beds came from this direction. Some of the quartzites and sandstones bear a striking resemblance to similar rocks outcropping in the West Coast Range, Tasmania, as observed by us near Mount Lyell. Especially may be mentioned a hard blue quartzite, and also a pink variety.

Mr. A. W. Howitt, F.G.S., who has examined the valuable collection of rocks from the glacial beds at Derrinal, made by Mr. Hollingsworth, is of opinion that very few, if any, of these rocks are to be found *in situ* south of Derrinal; and he suggests that the jasperoid rocks of East Gippsland may have furnished the jaspers which are so abundant in the Derrinal beds.

It is quite possible that during the great Permo-Carboniferous Ice Age parts of the Great Divide at least nourished local glaciers from which icebergs were shed into either a glacial lake or the sea; and thus, while it seems probable that the great bulk of the material came from the south, it may also be that rocks from the north-east and east were also deposited into the glacial beds accumulating in the district described by us.

There is some reason to doubt whether true till or boulder-clay exists in the district. There are certainly beds lying directly above the scored Silurian rocks very like in appearance to till; but when similar beds are found lying above stratified mudstone which presents none of those evidences of disturbance which, according to the received theory of the origin of till, we should expect to find, it seems premature to conclude that the beds in question are true till. At the same time, if the generally accepted theory be correct, it would be rather remarkable if we should nowhere find the till. Except a fragment or two of slate and a few quartz pebbles, none of the material in the glacial series resembles, so far as we know at present, any rock found *in situ* in the district—a circumstance which is decidedly against the till theory.

As to the various conditions under which the different glacial beds were deposited, we do not propose to enter at any length on the present occasion.

Messrs. Sweet and Brittlebank, in the paper already referred to, state that in their opinion the glacial conglomerates were deposited under water by the agency of floating ice near shore, and that their final arrangement is due to "moving waters." They state that their conclusions are in agreement with those formed by the officers of the Geological Survey of Victoria on this point, but we have been able to find very little in the writings of such officers which will throw much light on the statement of Messrs. Sweet and Brittlebank.

Mr. E. J. Dunn, F.G.S., writing of the Derrinal beds, states:—"Icebergs that started their career as glaciers alone would account for the phenomena presented by this conglomerate. The glaciers would, while gliding down their native valleys, accumulate in their mass vast quantities of earth, sand, clay, stones, pebbles, and masses of rock from the sides of the valley, and from the branch valleys running into it. As they pushed out into the ocean or lake, they would become detached, and were then driven by wind and current to the site of the present conglomerate. As they floated over or became stranded, the melting of the ice would set free the included rocky or earthy matter, which would fall to the bottom, and just in such a manner as sections of the conglomerate expose." That icebergs did become stranded over the Derrinal area is shown, according to Mr. Dunn, by the mass of bed-rock (christened Dunn's Rock by Professor Spencer) planed and scored in Lot A20, parish of Knowsley. Without inquiring whether Messrs. Sweet and Brittlebank rely, with Mr. Dunn, on icebergs to account for the smoothed and grooved appearances of the bed-rock, their explanation of the phenomena appears to involve the conclusion that not only the included stones but also the matrix of the conglomerate was carried from the land by icebergs or floating ice; that the berg, either before or after stranding, parted with the material it was conveying, and that this material, after being deposited, was finally arranged by "moving waters."

With respect to the smoothed and grooved surfaces of the bed-rock—of which a large number of instances have now been reported—there does not appear to be any good reason why the well-established theory of their glacier origin should be departed from. The action of icebergs is in general attested by the crumpling and crushing of strata rather than in the smoothing and polishing of their surfaces; and there is less difficulty in believing that, when the glaciation was at a maximum, either the ice-sheet or a local glacier passed over the surfaces in question—smoothing, polishing, and grooving them—than in endowing icebergs with physical properties which, so far as experience shows, they do not possess.

But if it is difficult to picture an iceberg forsaking its usual practices and smoothing instead of crushing the rocks it strands upon, it is still more difficult to imagine icebergs drifting from the ice-sheet, and either parting with their included and adherent material with such mathematical accuracy as to form well-marked stratified beds traceable over a large area of country, or parting with it in such a manner that after its deposition it could be arranged by "moving waters" in stratified beds.

We are of opinion that after the maximum extension of the ice-sheet a subsidence of the land now covered by the glacial beds took place, followed, probably, by several oscillations of level. Into the sea or lake now covering the submerged area, sub-glacial streams, bearing in suspension the fine matter produced by the grinding of the ice-sheet over its rocky bed, discharged themselves, and deposited the matrix of the stratified mudstones; while the bergs broken from the ice-front may, in the process of melting, have dropped into the beds then in course of formation the striated stones and other rocky material which they now contain. The appearance of the matrix when finely laminated, bending under and arching over the included stone, seems to strongly favour this hypothesis. The large erratics were, without doubt, transported to their present positions by the agency of icebergs. On the other hand, little direct evidence of the grounding of icebergs has been observed in this locality. The mudstones were deposited not far from land—in many cases in water of no great depth, and therefore within easy grounding distance of even moderately-sized bergs; and the beds, being stratified, would plainly show in contortions and crumplings where the impact of the floating ice-mass had taken place, but, although many fine sections of the mudstones are exposed on the several creeks in the district, no such disruption of the strata has been noticed by us.

Further examination may determine what affinity exists between the conglomerates and "till." At present their stratification and the appearance of the subjacent mudstones raise difficulties, and until fuller information is obtained it seems unwise to put forward even a tentative theory of their method of formation.

The third group of rocks of the series—the sandstones and free-stones—were deposited in fairly calm waters. Traces of false bedding may be seen, and the presence of included stones—which show a tendency to lie along the planes of stratification—point to the fact that the glacial conditions had not entirely passed away. The comparative scarcity and, in general, small size of the included stones suggest that the severity of the glaciation had become somewhat modified, and the fossils discovered in the Bald Hill sandstones, which bear a great resemblance to the sandstones of the Coimadai district, strongly support this view.

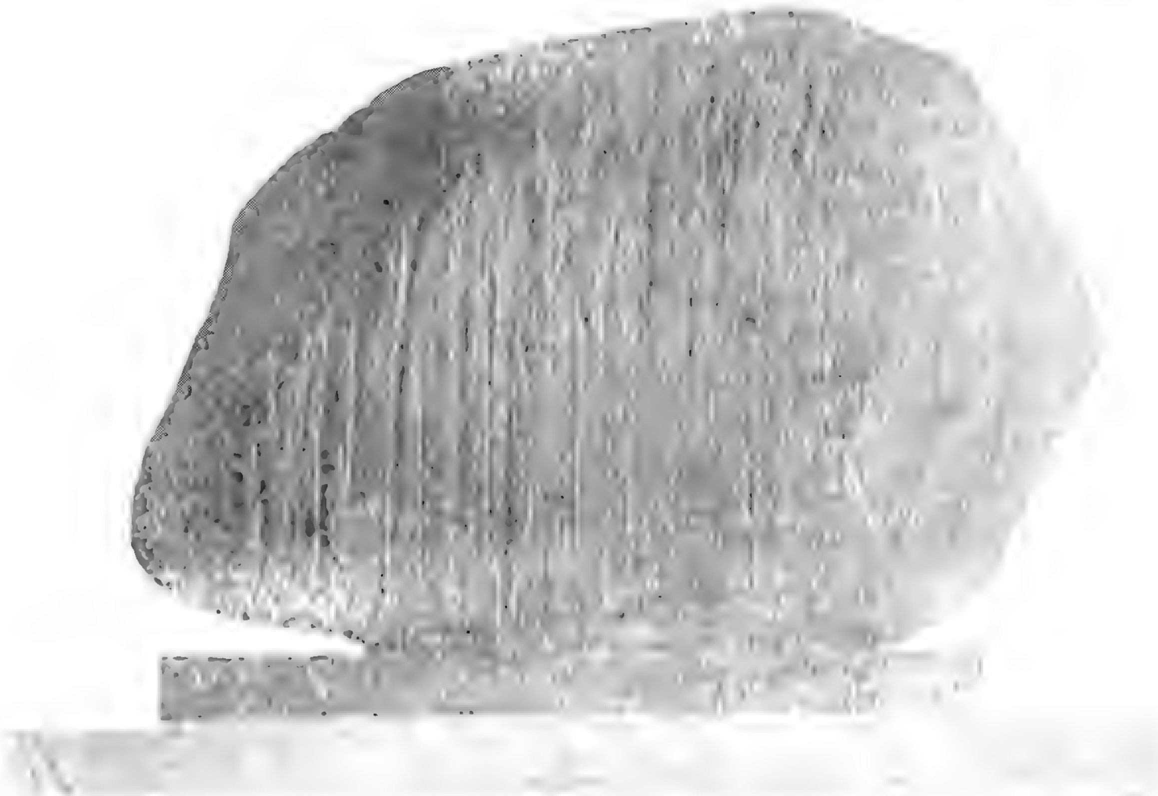
EXPLANATION OF PLATES

I. Striated boulder from mudstone—Lerderderg River.
II. "Wightman's Rock"—Coimadai.
III. Junction of scored Silurian surface and conglomerate—Pyrete Creek.
IV. Stratified beds overlying mudstone—Pyrete Creek.

7.—ARTESIAN WATER IN THE WESTERN INTERIOR OF QUEENSLAND.

By ROBERT L. JACK, F.G.S., F.R.G.S.

For the last seven months two members of the Geological Survey staff were engaged on work bearing on the question of artesian water in Queensland. Mr. A. Gibb Maitland was in the field for the whole of that time, and the writer for the greater part of the time, with some



Striated boulder from mudstone - Lerderberg River.

Wightman's Rock" Coimadai

Stratified beds overlying mudstone - Fyrete Creek

interruptions. The work is still unfinished, but the economic interest of the subject may be held to justify an account of the results so far being laid before the Association.

The bulk of the rain which falls in Queensland is intercepted by the belt of elevated country near the east coast. The country to the west does not receive, on an average, more than from a half to a third of the amount of rain which falls in the eastern coastal districts. It so happens that, owing to the nature of the soil, the western interior supports grasses of a kind infinitely superior to those of the coast, but in the long intervals between rains the rivers dry up for the most part, till it becomes a long day's journey from waterhole to waterhole. The result is that only a small proportion of the magnificent land is actually "available" for pastoral purposes, the distance to which cattle can "feed back" from the water before thirst compels them to return to drink being the limit of the country which can possibly be used. I may be excused for quoting what I wrote in the beginning of 1882, in an account of the Transcontinental Railway Expedition, to show the state of the country in dry seasons:—

"On making inquiries as to water between the Cloncurry and Winton, I learned that the country was about at its worst, there having been no rain for nine months except in very local showers. The usual route up the Gilliatt River and Mackinlay Creek to Beaudesert, and thence to Belkate, on the Diamantina, was practically closed for the season. I determined to go by Eastern Creek, where there had been some little rain. We had camped on the night of 20th December on the Gilliatt River, where it is crossed by the Hughenden Road. The waterhole had fallen to a puddle about 10 feet in diameter, and when we arrived we found it in possession of a large mob of cattle. After the water had been boiled twice and skimmed and decanted it was good enough to make tea with. The horses, however, could not be expected to like it, and on the 21st five of them were missing. They were not found till four o'clock. I thought we could reach the Eight-mile Waterhole on Eastern Creek (distant about 8 miles from our camp) before dark. We struck Eastern Creek just after sunset, about 2 miles below the Eight-mile Hole. In creeks in the "downs" it is very hard to tell which is the main channel, and we unfortunately selected one of the mouths of a tributary called Sadowa Creek. Finding no water in this, and in the belief that we were running up Eastern Creek, we followed Sadowa Creek for 9½ miles in the dark, when we had to camp (at 11 o'clock at night) without water. In the early morning of next day we packed up and retraced our steps. We found in Eastern Creek, a little above its junction with Sadowa Creek (surveyor's tree 33), a waterhole, which we afterwards found out to be the lower part of the Eight-mile Hole, but far separated by the drought from the upper part. The hole was very small. The water could not last another week, and a wide border of treacherous clay surrounded it. A large mob of cattle was crowded on the banks, but the animals only ventured in one by one, after they had become fairly maddened by thirst. Then they had a struggle for life in getting out. Four head of cattle were hopelessly bogged—alive, but doomed to a lingering death. We tied all the horses up, and watered them with the tin dishes. We had to run Eastern Creek down (8 miles) to Edington Station, which was the nearest place where water was certain, and we did not dare to camp the horses beside the boggy waterhole.

"On the 24th we again started to run up Eastern Creek. We found the Eight-mile Hole to be about 2 miles above the boggy hole at the 33-mile tree. In the latter four more cattle had got bogged. Thirteen miles further we passed another waterhole, but it was far too boggy to water the horses. In 5 miles more we camped on a little waterhole, apparently due to recent rain. On Christmas day we passed a waterhole at $2\frac{1}{2}$ miles, but it was dangerously boggy. At $5\frac{1}{2}$ miles and $11\frac{1}{2}$ miles we passed two waterholes with stony bottoms and quite safe. At $20\frac{1}{2}$ miles we camped on a fourth waterhole. The next day (26th) we followed the creek up for 19 miles without seeing any water, when, as the heat was terrible and one of the horses was knocking up, we camped for a time. All the water we had seen in Eastern Creek had been due to recent rain, which had apparently not extended beyond the limits of our yesterday's journey. After 7 more miles of travelling, mainly south—the creek having in the meantime run out—we camped (still without water) on the open downs to rest, as several horses were now quite exhausted. We packed up again just before sunset, and in 10 miles reached the Diamantina and camped on a waterhole about a mile and a-half below Kynoona."

The visit (1st and 2nd January) to Winton is thus described:—"The town depends entirely on a waterhole in Mistake Creek, 2 miles distant. The waterhole (which is narrow) at the date of my visit had shrunk up to about 400 yards in length, and was said to be 8 feet deep at the deepest point. It was expected that it might stand the demands made on it for three weeks or a month longer, when, if the drought still remained unbroken, the population of Winton would have to migrate in a body to Conn's Waterhole with their flocks and herds."

I shall only trouble you with one more extract, descriptive of the journey from Manuka towards Charters Towers:—

"The heat and drought had been telling very severely on the horses, and we were obliged to leave one at Manuka and let the others rest for two days. We left Manuka at 5 p.m. on 10th January, and travelled on by the moonlight. About 7 o'clock in the morning we reached and camped at a waterhole, due to recent rain, beside a straw building known as the Stone Hut (40 miles). One of the horses had to be left 15 miles short of the water, but was brought on to the camp in the afternoon. On the 13th we left the Stone Hut and camped—as one of the horses was too weak to go further—on a drop of very filthy water 10 miles further down Rockwood Creek. The water was due to the previous day's rain. We cut a hole in the clay on the margin, and let the surface water into it by a trench. The comparatively clean water thus obtained was ladled into tin dishes, from which we watered the horses. Two of the weak ones got stuck in the clay bed of the waterhole, and had to be pulled out by main force."

These impressions of a traveller faintly represent the old condition of affairs in times of drought, but the experiences of residents might furnish still more moving pictures: townships and households on short allowance of water; the feverish expectation of the teams coming from a long distance with a supply of water which the horses must have partly consumed on the journey; the travelling of stock in search of water and grass; the consternation on a station already short of water on the arrival of the statutory notice of the passing of a travelling mob, and the vigilance of the owners in seeing that the mob travels over the run at the statutory pace and clears out within the statutory time. Such tales must be heard over camp fires or in the homesteads of the pastoral districts before their full import can be realised.

Such being the condition of affairs, it became necessary to supplement the scanty supply of water provided by Nature, and the question was felt on all hands to be one of national importance. Much was done by the Government and private individuals in the way of conserving water in dams and tanks; but the cost was great, and the supply disproportionally small. In 1885 the trouble came to a head, for not only were cattle and sheep dying by hundreds of thousands, but even some of the western towns were threatened with extinction from the want of water. Mr. J. B. Henderson, Hydraulic Engineer, and the writer were therefore sent out to study the structure of the western country, and report whether there was a chance of success in boring for artesian water, and, if so, to determine the site of the first experiment. I came to the conclusion (in confirmation of speculations first made in 1881)* that the whole of the western downs offered a promise of artesian water, and Mr. Henderson selected Blackall for the first bore, as that township appeared to be in the direst straits. There are now over 200 bores in the interior, most of them successful, in the aggregate, I calculate, capable of producing 125,000,000 gallons per day, or 45,625,000,000 gallons per annum, and, in fact, producing not much less, since only a few of the bores are controlled. Such figures convey only vague ideas to most minds, and Mr. Henderson has kindly, at my request, supplied me with the capacity of some of the best known Australian reservoirs for comparison. Roughly speaking, the annual discharge of the Queensland artesian bores is 7½ times the capacity of the Yan Yean reservoir, 14 times that of the Malmsbury Coliban, 4½ times that of the Prospect, and 45 times that of the Enoggera reservoir.† It is difficult to estimate the improvement which these bores have effected in the conditions of life in the West.

It is now well known that all our artesian water, with trifling exceptions, occurs in the Rolling Downs or Lower Cretaceous formation. Over this formation the Upper Cretaceous or Desert Sandstone lies unconformably. The latter must have covered an area of at least 500,000 square miles, but has now been reduced by denudation to isolated tablelands.

The fact that water will find its own level affords the simplest explanation of artesian water supply. If we find a porous stratum sandwiched between two impermeable strata, and cropping up at a higher elevation than the site of a bore which pierces the porous

* See "Transcontinental Railway Report," pp. 2 and 3.

† The figures are :—

Yan Yean	6,400,000,000	gallons.
Malmsbury Coliban ...	3,255,000,000	,,
Prospect	10,812,313,000	,,
Enoggera	1,000,000,000	,,

stratum in question, the problem is solved, whether the water-bearing stratum, when mapped out, form a circle and the stratum be continuous within the limits of the circle, like a porous earthenware saucer sunk in clay, or whether, on the other hand, the stratum die out when traced along its outcrop or followed down the dip into the bowels of the earth. In the latter case the stratum is simply a pipe of more or less irregular sectional area, which the bore converts into an inverted syphon. In a clear syphon the water would rise with all the force due to the pressure of the head of water; but a syphon closely packed with sand is not only a syphon but also a filter, and in proportion to the openness or compactness of the sand the flow will be strong or feeble.

In mapping the eastern limit of the Lower Cretaceous formation, we find that at the base there is a series of soft, gray, very friable sandstones, grits, and conglomerates. This sandstone absorbs water with avidity. The rock is, moreover, so destitute of cement, or it may be that the cement is so soluble, that a lump of it on being saturated with water falls away to a heap of sand. We can therefore understand how, underground, where such strata are saturated with water, they may be correctly described by the drillers as "sand" instead of "sandstone." To this rock we felt it necessary to give a distinctive name, the "Blythesdale Braystone," as it is well developed at Blythesdale, near Roma, and somewhat resembles a sandy rock much in demand in the west of Scotland, under the name of braystone, for holystoning and scrubbing purposes.

This sandstone is first met with near the New South Wales border, at Whetstone, on the Macintyre River. The exigencies of travel took us down the Macintyre to Goondiwindi, and up the Weir River, where nothing but alluvial soil is met with till we reached Tarewinnaba, on the Weir. At this point the braystone is first seen, and is at once covered by the Desert Sandstone. A cake of Desert Sandstone extends from this point north, east, and west. The eastern and northern margins of this tableland were traced, and it was found that the Desert Sandstone overlaps the Ipswich Coal Measures, which are exposed in several places where the Condamine has cut through the overlying Desert Sandstone. On the north-western margin of this tableland, near Surat, the Desert Sandstone directly overlies the upper or shaly beds which give rise to the Rolling Downs, and which form by far the greater proportion of the strata of the Lower Cretaceous formation, so that the Blythesdale Braystone may be assumed to crop up beneath the Desert Sandstone somewhere between Dogwood Creek and Wiconbilla Creek. At Bendemere, on Yeulba Creek, the Desert Sandstone having been denuded by the stream, the upper shaly Rolling Downs Beds are directly in contact with strata understood to belong to the Ipswich Coal Measures, and the non-appearance of the Blythesdale beds is accounted for by a "fault." A few miles to the west the Blythesdale braystones are met with in great force, being succeeded to the north by the older (supposed) Ipswich Coal Measures, and to the south by the newer shaly members of the Lower Cretaceous formation. As the braystone is traced north-westward by Blythesdale, Roma, Taboonbay, Donnybrook, Hoganthulla, and the heads of the Warrego, its south-western edge merges into the downs formed by the shaly members of the Lower Cretaceous, and to the north-east it disappears under the Desert Sandstone (which is itself succeeded by bedded basaltic lavas). Nothing is more certain than that no member of the Lower Cretaceous formation appears on the north-eastern side of the Desert Sandstone and basalt tableland, which forms the divide between the waters draining southward into the Great Australian Bight and those draining eastward into the Pacific. In some places, however, as at the head of the Warrego on the Bight side, and at the head of the Nogoa on the Pacific side of the almost imperceptible watershed, the denudation of the Desert Sandstone (which apparently has a very uneven bottom) exposes larger or smaller areas of the Blythesdale Braystone.

On the divide between the head waters of the Warrego and Barcoo the Desert Sandstone remains as a tongue which covers the whole of the outcrop of the Blythesdale braystones, and on its western margin directly overlies the shaly members of the Lower Cretaceous formation. A glimpse of the braystones is seen at the head of Birkhead Creek, covered to the north and east by the Desert Sandstone, and succeeded to the south-west by the shaly beds of the Rolling Downs.

Further north, on the head waters of the Barcoo and the Thomson, the Desert Sandstone extends as a comparatively narrow tongue as far west as Barcaldine. From beneath this formation the Blythesdale braystones emerge at a point on the heads of Aramac Creek, about 35 miles north-west of Jericho, and have been followed northward through nearly 2 degrees of latitude, until it is again covered by the Desert Sandstone, in the vicinity of Corinda Station. The western edge of the Desert Sandstone rests directly on the Lower Cretaceous shales from this point as far as Hughenden, and the Desert Sandstone forms an unbroken escarpment of about 80 miles in length, and entirely conceals the Blythesdale braystones from view.

The convenient phrase, "the exigencies of travel," must again be employed to explain the difficulty of running with accuracy two lines which may be 20 or 30 miles apart. Granting that the two men employed can do a good deal on horseback, they must keep in touch with the main camp, for a survey party as well as an army "marches on its belly," according to the saying of Frederic the Great, and on a long journey horseflesh must be husbanded with care. For this reason attention was, north of the Warrego, mainly directed to the delimitation of the outer or eastern boundary of the Lower Cretaceous formation. The presence of the Blythesdale braystones, however, has been ascertained, as has already been mentioned, at different points as far north as Corinda Creek, a tributary of Torrens Creek, operations having had to be suspended at Hughenden.

In the region where an attempt has been made to map the whole area covered by the outcrop of the Blythesdale braystones—viz., from near Chadford, on a head of Yeulba Creek, to the Warrego—the outcrop forms a belt varying in width from 5 to 25 miles. The invariable position of this belt on the outer edge of the Lower Cretaceous area leaves no room for any reasonable doubt that it is composed of the beds lying at the base of the formation; but apparent dips have proved confusing and unreliable, so that I have no confidence in any estimate of the total thickness of strata represented by the outcrop. I incline to the belief that on the whole the angle of dip is very low—perhaps in many instances no more than the fall of the ground. However, an angle of 1 degree, or 1 in 57, would give a thickness of 460 feet for an outcrop of 5 miles wide; and from the evidence afforded by numerous bores I am prepared to admit that this thickness is by no means over estimated.

Hitherto it has been convenient to speak of the series of beds designated the Blythesdale Braystone as being of similar composition throughout. This, however, is not the case, as the braystone of normal composition is "parted" in places by beds of sandy shale and calcareous sandstone. We may imagine coarse sandy and gravelly sediments brought down to the margin of a shallow Lower Cretaceous sea by numerous tributary rivers, and spread out along the shore and out to sea by the action of waves and currents. Such material could only travel along the bottom, being too coarse and of too high specific gravity to remain in suspension, as a general thing, far from the mouths of rivers. The influence of wave-action, at least, would cease when the sea attained even a moderate depth. I am inclined to believe that the sea in which the Blythesdale Braystone was deposited and distributed—viz., the sea which divided the Australian continent from north to south into two islands—was very shallow throughout, and may have been swept from end to end by currents sufficiently powerful materially to aid wave-action in the distribution of the sand and gravel. Otherwise I do not know how to account for the wide distribution of the sand and gravel which is evidenced by the artesian wells. I imagine, further, that the later but continuous period to which the argillaceous Lower Cretaceous deposits belong was one in which a marked subsidence of the interior of this sea took place. The wide distribution of the Blythesdale sands has a parallel in a newer geological period in the enormous extension of the Desert Sandstone. Unless I had seen it with my own eyes, I should have had a difficulty in conceiving that heavy gritty sand could be so widely distributed as it is in the latter case; but, having seen it, I can believe that the Blythesdale sands may be equally extensive.

It may be assumed that the Blythesdale and Desert Sandstone periods were both characterised by heavy rainfall, producing rapid denudation of the land, and possibly by prevalent rough weather at sea, causing violent wave-action. At the same time the intercalation of some argillaceous sediments among the Blythesdale braystones need cause no surprise, as they would be the natural result of occasional spells of dry weather on land or comparative calms at sea. The wonder is that there should be so few. It is not likely that the intercalated argillaceous sediments are continuous over the whole area occupied by the Lower Cretaceous formation. They are more likely to be lenticular at the margin, and to spread out and thicken towards the interior of the area. The Blythesdale Braystone, therefore, although it may locally be split up into two or more beds by the intercalation of comparatively impermeable strata, I believe to be practically a continuous deposit.

It has already been mentioned that the Blythesdale Braystone is, over a large area, covered by the Desert Sandstone. Taking this into account, and also the fact that the actual breadth of the outcrop, where it is not covered by the Desert Sandstone, has not been mapped, we are still uncertain of the total area of the outcrop. I think, however, we are safe in assuming an average breadth of about 5 miles. In his Annual Report for the year 1892, Mr. Henderson made what I then thought a very liberal allowance when he based a calculation of the area of gathering-ground on the assumption that "the aggregate breadth of the outcropping edges" was one-eighth of a mile. In the light of the recent investigation I feel tolerably confident that the breadth of the basal beds (the Blythesdale Braystone) is at least forty times as much, not to speak of beds of similar composition on higher horizons, which makes a material difference in the conditions of the problem. Assuming that the total length of the ribbon representing the outcrop in Queensland of the Blythesdale Braystone is 1,000 miles, and its average breadth 5 miles, this outcrop alone would give a gathering-ground or intake of 5,000 square miles. An average of thirteen meteorological stations along the line of outcrop, taken from the map issued with Mr. Henderson's last report, gives roughly for this area a mean annual rainfall of 27 inches, which is considerably greater than that of the interior of the downs country.

The comparative altitude of the outcrop of the Blythesdale braystones and the western country where the artesian wells are situated is an all-important factor in the calculation. The surface level has not been reliably ascertained at the sites of most of the private (successful) bores. From Mr. Henderson's last report we learn that the site of the Government bore at Tambo is 1,325 feet, and this is certainly one of the most elevated sites Muckadilla comes next at 1,169 feet. The greater part of the area over which flowing artesian water has been obtained is much lower than either of these two places. The Blythesdale braystones attain their highest observed altitude of 1,700 feet above the sea-level at Forrest Vale, on the Maranoa, and the altitude of the outcrop gradually falls to 800 feet at the New South Wales border, and probably is almost at the sea-level near the Gulf of Carpentaria. I cannot speak with confidence of the extension of the lowest beds of the Lower Cretaceous formation into New South Wales and Victoria, but, as the cliffs on the coast near Coorang are supposed to be Tertiary, the lowest beds of the Lower Cretaceous, if present, must be beneath the sea-level at the Great Australian Bight.

The outcrop of the Blythesdale braystones is crossed by several large streams—Blyth's, Bungil, Bungeworgorai, and Amby Creeks, the Maranoa River, Hoganthulla Creek, the Warrego River, Birkhead Creek, and the eastern tributaries of the Thomson River. All of these streams run only for a small portion of the year, but while they run a rock of the bibulous nature of the Blythesdale Braystone must be absorbing water greedily, and the water must not only spread laterally but must also fill up as much of the underground portion of the stratum or strata as had been emptied by leakage.

Two kinds of leakage might affect the bibulous beds at the base of the Lower Cretaceous formation in a sufficient degree to be worth consideration for the present purpose. Suppose the beds to dip seaward and beneath the sea, and either to rise to the ocean bed or to dip at a lower angle than the slope of the sea-bed, there would be a leakage into the sea. And again, suppose (what we believe to be actually the case) the outcrop of the beds to occur at gradually lower levels till it attains the sea-level, there would be a leakage in the form of springs or into river beds all along the line. In either case the leakage, however compact the beds might be, would not cease till the water-level in the beds was reduced to the level of the sea, unless the head of water were from time to time replenished.

Some evidence has been adduced to prove that leakage of the first kind actually takes place. Professor David, in a lecture in November, 1893, described "powerful springs of fresh water at Port Macdonell, rising up from the floor of the ocean at some little distance from the shore and discolouring the water for some little distance around." Again, Mr. G. S. Griffith, in the Reports of the Australasian Association's Christchurch meeting, says that "along the south coast of Australia, between Warrnambool and the Murray mouth, the sea literally bubbles up with fresh water which has leaked up through the sea-sands." Mr. E. F. Pittman says in the paper just read before this Section—"The artesian basin may extend to the southward, possibly even under the Eocene beds of the Lower Darling, the north-western portion of Victoria, and part of South Australia to the Coorong, where fresh water has, I believe, long been known to escape from the beach." The observations of Professor David, Mr. Griffith, and Mr. Pittman all evidently refer to the same district. If Lower Tertiary rocks form the cliffs, the fact that the water leaks from them above the sea-level has no direct bearing on the question of an outlet for the Lower Cretaceous strata. The Tertiary cliffs may, for any evidence there is to the contrary, extend beneath the sea, and leak out there sufficiently to account for the phenomena referred to by the observers quoted. I cannot deny that the Lower Cretaceous formation may crop out at the sea bottom still further out to sea, but the fact is not proven, and in the nature of things it is not likely to be proven.

Nor is evidence of the second kind of leakage to hand. The outcrop of the Blythesdale Braystone as it falls away from its highest altitude at Forrest Vale down to the Macintyre River is not very conspicuously marked by springs. Indeed, given a continuous outcrop of a stratum such as this falling away from a higher level to a lower, it is easy to understand that water permeating the stratum would simply saturate it, and would never, except where locally covered by clay, rise in the form of a fountain, though it might fill hollows in its surface, such as are made by river courses or covered by alluvial sands and gravels.

The mapping of the "Blythesdale Braystone" is the work of the last eight months, and consequently no observations have yet been made to determine the proportion of the water brought down by any given river crossing their outcrop which is absorbed by the bibulous strata. A calculation on similar lines has, however, been made by Mr. H. C. Russell, with regard to the Darling River. Mr. Russell writes*:— "The mean rainfall on the Darling River catchment for the past ten years has been 22·14 inches, and of this only $1\frac{1}{2}$ per cent., or 0·33 inches of rain, passes Bourke in the river. If 25 per cent. of it, which is equal to 5·53 inches of rain, passed away in this river, as it does in the Murray, there would be seventeen times as much water passing Bourke as now actually does pass . . . . and we ought, therefore, to have an underground water supply at least equal to sixteen times as much water as passes Bourke now. . . That we do not find it in the Darling is to my mind proof that it passes away to underground drainage."

* In "The Source of the Underground Water in the Western Districts," Journ. Royal Society N.S. Wales, 1889.

Referring to Queensland localities, Mr. James Tolson says*:—"I have seen 10 inches of rain fall within 24 hours on the high desert country between Uanda and the Cape River Gold Field, and not a drop run off the surface, the whole of it having been absorbed by the porous formation. I have also ridden through Torrens Creek after its being uncrossable for a week at the Lammermoor Crossing, and with a width of 70 yards, when the water was well above the saddle-flaps, and 40 miles lower down on the same day the stream was not more than 30 yards wide, and not up to the horse's knees" The first part of the above shows the absorbent qualities of the Desert Sandstone, and the second of the Blythesdale beds.

Mr. Russell's figures, if applicable to Queensland, prove more than the absorption of the water by porous strata. If they are reliable—and I see no reason to doubt their accuracy—and again, if they are applicable to Queensland (which is very likely, considering the exceptionally bibulous character of the Blythesdale Braystone), the bibulous rocks at the base of the Lower Cretaceous must annually, or at least every wet season, absorb an amount of water which would severely tax my arithmetic. And if the bibulous rocks absorb such an amount of water, they must first have been drained of water to a like extent. How would such a drainage be effected? Certainly not by the bores, or there would have been a difference in the character of the rivers of the district before and after the commencement of boring; and the output of the bores, great as it is, is, after all, a mere bagatelle compared to the amount which would be "lost" by the rivers of Queensland, supposing them to behave like the Darling. This *reductio ad absurdum* need not be further dwelt on. Certainly the drainage of the Blythesdale braystone is not effected by the bores. The only conceivable agent capable of effecting it is the leakage in the sea bottom. Thus, although we have no direct proof of the latter, I hold that it is proven if once it be shown that the Queensland rivers suffer a loss of water comparable to that of the Darling.

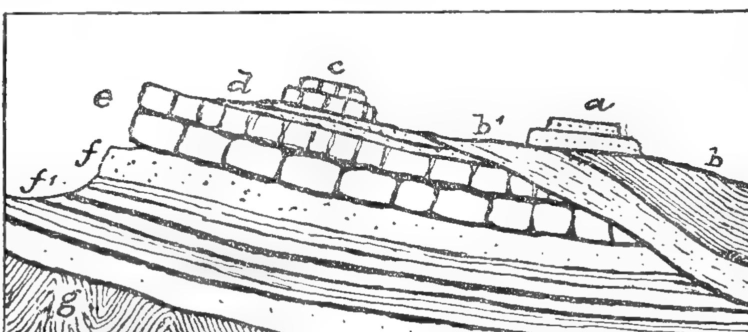
If the foregoing conjectures as to the drainage of the upper portion of the Blythesdale Braystone and its periodical replenishment by rivers in the wet seasons be correct, it is possible to conceive of a long drought reducing the water to the sea-level in such of the strata as are open at one end to the sea. If the strata can imbibe as much as the parallel case of the Darling would lead us to infer, they must lose, by leakage into the sea, nearly as much as they imbibe, and the amount drained from them by the bores will be insignificant by comparison. If the water-bearing strata communicate with the sea, the water can never fall below the sea-level, but if it stood long at that level it would become salt. Some hold that the water of our artesian wells is sea water raised to the surface by heat or the expansion of gas; but if it were sea water it would not lose its salt by filtration, and moreover it would be forced up along the bedding-planes of the strata, and issue along the line of outcrop in salt water springs. That the water of the bores is fresh (or contains only such mineral salts as it might acquire from the containing strata) proves that it gravitates from the outcrops of the strata and not from the

* "Australasian Pastoralists Review," 15th December, 1892.

sea. Numerous well-known instances of fresh-water springs rising out of the beach sands, and even in the bottom of the sea, show that even a feeble pressure at the back of an underground stream of fresh water is sufficient to keep out the salt water.

It has already been mentioned that the Desert Sandstone covers a large area of the outcrop of the Blythesdale beds. Although the former is less bibulous than the latter, it is still very absorbent. Mr. Tolson's remarks about 10 inches of rain having fallen on this formation without making the streams run are very much to the point, and I can confirm his observation from a large experience of Desert Sandstone country. Now, the Desert Sandstone, thus saturated with water, lies like a full sponge on the top of the outcrop of the Blythesdale Braystone, and must tend to equalise the supply by feeding the latter long after the rivers have ceased to run.

The water-bearing beds of the Lower Cretaceous formation may not only be supplied from above by the Desert Sandstone, but I strongly suspect may be reinforced by the agency of strata geologically on a lower horizon. Till lately the best information available led me to the belief that the Trias-Jura formation on Ipswich Coal Measures was succeeded conformably by the Lower Cretaceous or Rolling Downs formation, but in the last trip I have seen unmistakable evidence of an unconformability between them. It may be that the bibulous lower members of the Cretaceous rest directly on sandy members of the Ipswich Coal Measures, which dip in the same direction in the manner shown in the following diagram :—



a Desert Sandstone (Upper Cretaceous.)
b & *b'* Rolling Downs Formation (Lower Cretaceous.)
b Shales
b' "Blythyesdale Braystone."
c Darling Downs Basalt.
d Slates, Sandstones & Coal Seams.
e Toowoomba Basalt.
f Murphy's Creek Sandstone.
f' Shales, Sandstones & Coals of Ipswich.
(*c* to *f'*: Trias-Jura.)
g Palaeozoic Rocks.

In this case the sandstone beds above the Toowoomba basalts and the Murphy's Creek beds below would feed the Blythesdale Braystone, and still further tend to equalise the supply by making good the loss entailed by the supposed connection of the latter with the ocean.

I have spoken so much of the Blythesdale braystones that I may have created the impression that they are the only water-bearing beds of the Lower Cretaceous formation. Their importance warrants the attention they have received, but there are water-bearing beds on higher horizons. Many of the bores have struck two or more supplies of water. Sometimes the first supply does not rise to the surface. A second may reach the surface and flow over, while a third may considerably increase the supply. The feeble supply of the upper beds may be explained by the fact that they do not crop out at high altitudes. As a rule the higher beds must be more limited in extent, and must draw their supplies for the most part from local sources—in other words, they crop up where the rainfall is least, and the outcrop has less chance of being crossed by streams running long enough to fill them up with water.

It is not asserted that all the strata in which artesian water has been struck have a connection with the sea. The Blythesdale Braystone as a whole probably has such a connection, for on no other theory can we account for the loss of water by such streams as the Darling River and Torrens Creek; but it "stands not within the limit of belief" that sandy beds only a few feet or yards in thickness can persist for hundreds of miles. Such a closed tube as would be formed by a bed thinning out at a depth, not being subject to leakage at the sea-level, would, on being tapped by a bore, form an inverted syphon in which water would rise nearly to the level of the head of water formed by its outcrop; and if it were drawn upon by numerous bores (the chance of its being replenished being less than that of the lower beds) the water might in a long drought be reduced to the level of the site of the lowest bore, or, in other words, could not flow again till the head of water had been added to by further rain.

The varying depths at which the water-bearing beds are met with, even in bores not far apart, prove that the strata are subject to considerable undulations or dislocations. Another circumstance indicative of undulation is the temperature of the water of the bores, which is, in many instances, greater than the depth at which the water has been struck would warrant on the supposition of a normal increase with depth. This argument for undulation has been well enforced by Professor David in his article on Artesian Water in New South Wales and Queensland, in the Transactions of the Royal Society of New South Wales for 1893. Another explanation of the high temperature has been suggested—viz., that the water has come in contact with igneous rocks still retaining a considerable amount of their original heat. This is an explanation, however, which I hold to be inconsistent with the fact that the Lower Cretaceous is a formation in which absolutely no evidence of contemporaneous igneous action within the Queensland area has been detected, in which respect it presents a strong contrast to the preceding Trias-Jura and the succeeding Desert Sandstone. The effect of a dislocation or fault throwing down a bed of sandstone sandwiched between impervious claybeds would be to stop any communication with the sea which it may have had originally, and convert it into a closed tube.

An idea prevails in some quarters that every successful artesian bore is successful because it has struck the channel of an underground river; but against this theory some fatal objections may be raised. A river ceases to be a river when it enters the sea. Now, the Blythesdale beds are marine, as their outcrop (the nearest part to the old coast-line) contains marine fossils, as do the argillaceous strata above them; and we cannot imagine a river bed meandering through a sea-bottom. Besides, the wide area over which the water-bearing beds have already been met with in bores renders the idea that they are all river beds in the last degree improbable.

The mountains of New Guinea have been pointed to by some as supplying the necessary "head" for the artesian water of the interior of Queensland. Lower Cretaceous rocks are known to exist in Queensland not far from the Gulf of Carpentaria, and it is more than likely that the base-beds of the formation are actually below the sea-level in Queensland, and that they may sweep beneath the Gulf and the western portion of Torres Straits, and rise to the surface in Dutch New Guinea. But this necessarily implies that these beds must crop out beneath the sea, and such a leakage would be the result that I doubt if any head of water in New Guinea would raise the water in Queensland above the sea-level.

The Himalayas and even the Andes have been supposed by others to be the gathering-ground. It is not conceivable that any fissure or network of fissures could be kept open from the Andes or Himalayas to Queensland. Neither is it conceivable that any stratum could extend continuously for such distances, remain without interruption of such a character as to be a channel for water, sweep beneath the intervening oceanic depths and be protected throughout by a cover of impermeable rock; *all* of which conditions would have to be fulfilled before we could accept this theory.

Another theory, that of "rock-pressure," is thus concisely formulated in the "American Geologist" (vol. v., p. 300) by Mr. Robert Hay:—"All rocks in the earth's crust contain some water. The more porous rocks contain the greater quantity. At a distance below the surface the superincumbent strata subject the rock masses to enormous pressure." On the assumption that the average specific gravity of the deep-seated rocks of Kansas is 3, Mr. Hay calculates that "a prism of the rocks to the depth of 600 feet, and 1 inch square, would weigh 718 lb., which is equivalent to a pressure of 52 atmospheres. If, then," he continues, "25 feet be taken as the measure of a column of water equivalent to one atmosphere, the rock-pressure would be more than the equivalent of a column of water twice this height. Let a water-bearing stratum at a depth of 600 feet, as at Richfield, be pierced by the drill, we should then have the rock-pressure of 52 atmospheres squeezing the water out of the rock pores, and, granting sufficient plasticity in the rock and a sufficient quantity of water, it must rise in the tube which has only a pressure of one atmosphere upon it. . . . A bed rock with mobile molecules at or near saturation under this enormous pressure must cause in a narrow tube a flowing well."

Now, in such a stratum as Mr. Hay has imagined, the effect of pressure would simply be to close up the spaces between the solid grains, and diminish the stratum's capacity for carrying water, and the surplus water would be forced into the underlying or overlying strata, if these were sufficiently permeable, or, if not, the surplus water would be forced out at the outcrop of the stratum. In any case, the water-carrying capacity of the stratum would be permanently impaired, or, if the pressure were great enough, entirely destroyed.

Another idea is that there are in the bowels of the earth vast reservoirs of water—not filling up the interstices of porous strata, but actually filling up void spaces among the rocks—and that the presence of superincumbent rock is such that on these reservoirs being pricked by a bore the water rises as in the tube attached to a squeezed rubber bag. I can imagine the roof of such a reservoir tumbling in, in which case the water could only rise to an extent dependent on the bulk of the rock which had fallen into the water; or supposing the whole mass of water to be displaced by an equal mass of rock, it must either occupy the space formerly occupied by the rock or get away laterally into crevices in the rocks above the former surface of the water, if such crevices are available, but at most would not rise above the level of the rock which had fallen in. To take the case of a shaft communicating with extensive underground workings:—Let us suppose the workings to become filled with water and the roof suddenly to collapse. If the quantity of water were large enough to fill up the shaft and flow over, it would probably do so at first, and even flow over the mouth of the shaft; but the water would simply stand in the shaft, supposing the latter to be water-tight, and there would merely be a tube filled with water, and in no sense an artesian supply. If, on the other hand, an underground reservoir were to remain unfilled by the tumbling in of the rocks above it, the rise of water in a bore tapping it would depend on the head of water supplying the reservoir, no matter how extensive the latter might be. My belief is, however, that such underground reservoirs are not common objects in nature. Caverns in limestone in which large streams disappear, to reappear at lower levels, are by no means unknown, but such caverns are for the most part confined to levels within the reach of the solvents conveyed by the atmosphere.

It is not within the scope of a single paper to consider the whole subject of artesian water. My object in addressing this Section has been to point out what light has been thrown on the question, so far as it affects Queensland, by recent investigations. We have shown that an intake at sufficient altitude to account for the flow of water in the artesian bores of the west exists along the eastern margin of the Lower Cretaceous; and having found a simple explanation in agreement with known physical laws, I go no further in search of another. I have argued that the loss of water by the Darling River, and probably a similar loss of water by the Western Queensland rivers, proves that the water-bearing strata must leak into the sea, and hence that unless the strata be periodically replenished the sea-level would ultimately become the level to which the water would rise. A drought sufficiently long to bring about this result would no doubt have for a prior result the destruction of the greater part of the land fauna of this part of Australia, including the *genus homo*. Far short of this, however, we can conceive of the temporary diminution or cessation of the flow of some, at least, of our artesian wells. The amount of water contributed to the water-bearing strata of the Lower Cretaceous formation every wet season by such rivers as the Darling is so great, and consequently the amount of leakage into the sea is so great, that the quantity abstracted by the artesian wells, large as it is, and even if it were ten times greater, is insignificant by comparison. Finally, as the leakage into the sea is so vast, and is entirely beyond human control, the draught on our underground supply made by artesian wells is not worth controlling. I make no apology for the fact that my views on this important question are not those which I held twelve months ago. My colleague, Mr. Maitland, and I went out into the field with the object of laying a foundation of facts for the guidance of ourselves and others who may wish to rest their theories on solid ground. It is for others to judge whether we have succeeded.

8.—NOTE ON THE CRETACEOUS ROCKS IN THE NORTH-WESTERN PORTION OF NEW SOUTH WALES.

By EDWARD F. PITTMAN, A.R.S.M., Government Geologist, New South Wales.

During a recent trip I made a geological examination of a considerable area of New South Wales lying to the west of the Paroo River, and bounded by the Queensland boundary on the north, and a line joining Wilcannia and Broken Hill on the south. The distance travelled in a buggy was about 1,150 miles, and the route followed was from Broken Hill in a northerly and north-easterly direction to Trisigo, near Wanaaring; thence westerly to Milparinka; thence northwards *viâ* Mount Poole to Olive Downs and Warri Warri, on the Queensland border; thence southwards *viâ* Mount Browne to Mount Arrowsmith; thence in a generally south-eastern direction to Wilcannia; and thence westwards to Broken Hill.

Previous examinations of portions of this country have been made by Mr. Geological Surveyor H. Y. L. Brown (now Government Geologist of South Australia), in 1881 (*vide* "Albert Gold Field—Artesian Water," Legislative Assembly paper, 1881); by Mr. C. S. Wilkinson, late Government Geologist of New South Wales, in 1884, and again in 1887 (*vide* Ann. Rept. Dept of Mines for 1884, pp. 146-7, Report on Silver-bearing Lodes of the Barrier Ranges, Legislative Assembly paper, 1884, and Ann. Rept. Dept. of Mines, 1887, pp. 137-139); by Mr. Geological Surveyor Wm. Anderson (now of the Geological Survey of India), in 1891 (*vide* Ann. Rept. Dept. of Mines and Agriculture, 1891, p. 254); and, lastly, by Mr. Geological Surveyor J. B. Jaquet, in 1892 (Ann. Rept. Dept. of Mines and Agriculture, 1892, pp. 137-145). Briefly summarised, their reports are to the effect that this territory consists of several areas of Palæozoic rocks, intruded by dykes of granite, diorite, &c., and containing deposits of such metals as gold, silver, copper, and tin, flanked or surrounded by Cretaceous or water-bearing sediments, covered in places by drifts, clays, and sands of Pleistocene and recent origin.

The examination recently made by me convinces me that the Palæozoic areas shown on our Geological Map must be considerably reduced, and that, on the other hand, the area occupied by the Cretaceous or water-bearing rocks is much larger than was previously supposed.

Perhaps the most important conclusion at which I have arrived is that the artesian basin has probably a much further extension *southwards* than had been previously assigned to it. It has been hitherto considered that the southern boundary of the Cretaceous basin was formed by a bar or buried range of Palæozoic rocks stretching westwards from Cobar through Wilcannia to Scrope's Range. At Wilcannia the rocks forming this bar were regarded as *Devonian*, and this opinion appears to have been formed on lithological evidence only, as there is no record of any Devonian fossils having been found *in situ*, nor of any geological section in which the relation of these Wilcannia sandstones is described with regard to older sediments. But in my opinion the lithological character of these sandstones points to their being of Mesozoic rather than of Palæozoic age, and the small amount of geological evidence that can be obtained from a surface examination seems to strengthen that view. Deposits of hard sediments which I observed at certain localities, such as at the west of the Koko Range, at Kooningberry, at the western side of Mount Murchison, at the western side of Woychugga Lake, at the Springs, and at the northern end of Scrope's Range, may be, and probably are, of Devonian age. They consist of hard, dense, thick-bedded quartzites, similar in character to those of Mount Lambie, near Bathurst, showing *slickensided* joints, and, as a rule, lying at a high angle with the horizon. But the rocks at Wilcannia are of a different character; they consist of rather soft, yellowish, greyish, and whitish grits and sandstones, frequently containing bands and pockets of kaolin, and lying as a rule at a very low angle of inclination. In fact, while one set of rocks shows abundant evidence of both metamorphism and disturbance, the other is remarkably free from signs of either. My conclusion in regard to these rocks is that they are probably of Upper Cretaceous age, and if this be correct it means that, instead of the Cretaceous basin being cut off on the south by an east and west boundary through Wilcannia, there may be a deep channel somewhere between Woychugga Lake and Mount Manara, by which the artesian basin may extend far to the southwards—possibly even under the Eocene beds of the Lower Darling, the north-western portion of Victoria, and part of South Australia to near Mount Gambier, where fresh water has, I believe, long been known to escape from the beach. In the neighbourhood of Port Macdonell, near the S.E. extremity of South Australia, several strong springs of fresh water have been described as coming up from below the level of low water, and discolouring the ocean for some distance around. These subterranean rivers are thus referred to by the Rev. J. E. Tenison Woods in his book, "Geological Observations in South Australia," pp. 363 and 364:—"Close to Mr. Ellis' station, within about five miles of Mount Gambier, there is a whim erected over a small hole in the rocks. Underneath this, at the depth of about 70 feet, there is a long passage or cavern through which a deep stream of water flows. It has been as before mentioned, *there are several natural springs where large quantities of water boil through the limestone rock.* In spring or summer there is a distinct stream or ripple visible on the surface, as seen from the top of the well. Doubtless this is one of the many passages through which the surface water drains from this district. . . . . The course is about S.E., and either it comes to the surface in one of the numerous *freshwater springs* which abound on the coast, or else it comes up under the sea like the water resulting from the Katavothra in Greece."

It is quite possible, however, that this water may come from the Eocene beds. In any case the probabilities of the artesian water-bearing beds extending southwards of Wilcannia appear to be strengthened by the occurrence of Upper Cretaceous sandstones at Bidura, near Balranald (as reported by me in June last), and also by the fact that a deep channel has been proved to extend from Urisino—where two fine supplies of water have already been obtained—southwards along the west of the Paroo River in the direction of Wilcannia, for I understand that several deep private bores were put down on Momba Station. The deepest of these was 2,000 feet, but I believe that boring operations were discontinued before bed rock was reached.

On my journey northwards from Broken Hill, the Upper Cretaceous rocks were first met with at Fowler's Gap, to the north-east of Corona Station. A good section of these beds is seen four miles west of Sandy Creek Bore, and also about twelve miles west of Bancanya Bore, where they form the eastern escarpment of the Koko Ranges. They consist of soft, yellowish-grey sandstones and grits, showing false bedding in places, sometimes stained by peroxide of iron, and in no respect distinguishable (lithologically) from the sandstones subsequently examined at Wilcannia. On the western flanks of the Koko Range these sandstone beds are seen to lie unconformably on the upturned edges of slate rocks of probably Upper Silurian age. The sandstones here dip to the east at a very low angle (10°), but as they are followed to the east the dip is seen to increase, until at the eastern side of the range it attains an angle of 45°. It is unusual to find Upper Cretaceous rocks so highly inclined as this, but at least one instance of as high a dip was observed on the Isis River, Queensland, by Mr. Rands, Assistant Geologist. (*Vide* Geology and Palæontology of Queensland and New Guinea—Jack and Etheridge, p. 545.)

In many other localities to the northwards, as at Milparinka, Mount Poole, Mount Stuart, and in the Grey Ranges, similar soft sandstones, but dipping as a rule at a very slight angle, are found forming the summits of the hills, and frequently they alternate with, and in some instances are overlaid by, hard rocks, which, though somewhat of the nature of quartzites, are perfectly distinct from the Devonian rocks already alluded to. The latter are highly metamorphosed homogeneous quartzites, while the Upper Cretaceous rocks appear to be grits which have been altered by thermal springs; they have, in fact, become opalised or porcelainised by having all the interstices between the sandgrains or pebbles completely filled by silica deposited from solution. One of the characteristics of this porcelainised rock is the manner in which it breaks up on the hilltops. It is very hard, but also extremely brittle; it "rings" like porcelain when struck, and breaks with a conchoidal fracture. The prolonged heat of the sun followed by rapid cooling—owing to sudden thunderstorms and the frosts of winter—causes the larger beds to break up rapidly, and consequently it is rare to see an outcrop of solid beds, the hilltops being covered with a more or less rounded shingle.

Evidences of the agency of thermal springs in these Upper Cretaceous rocks are frequent. At the Peak (Mount Stuart Ranges) ancient springs have left mounds of curiously banded limonite; showing that many of them contained ferruginous solutions—indeed, the Upper Cretaceous rocks of this district are characterised by the occurrence of considerable quantities of iron oxide.

Near the top of the Desert Sandstone occurs a thin bed (about 3 inches in thickness) of conglomerate, the pebbles of which are of every conceivable colour, and the weathering of this conglomerate has resulted, in places, in the hillsides being strewn with highly polished pebbles of white and pink quartz, banded agates and chalcedony, jasper, carnelian, &c. The highly polished surfaces of these pebbles are probably due to the action of the wind and sand. Considerable numbers of these pebbles were seen at Yandaminta, about twenty miles west of Mount Poole. From the northern end of the Waratta Ranges to the Queensland border, the country consists almost entirely of Upper Cretaceous rocks (Desert Sandstones), and, generally speaking, it may be said that the Lower Cretaceous or Rolling Downs formation does not show at the surface over this district, being covered by either Upper Cretaceous or Pleistocene deposits of greater or less extent. In the spoil heaps of the wells, however, which have been sunk by many of the squatters, are to be seen characteristic blue clays and sandy shales with *Belemnites*, *Maccoyella reflecta*, *M. corbiensis*; also a very large bivalve, which Mr. Robert Etheridge, Junr., believes to be new, and a univalve which, according to the same authority, belongs to the genus *Rapana*. I also obtained a portion of the stem of a tree-fern (not yet determined) from the Upper Cretaceous rocks of Mount Stuart.

One of the most interesting features of this district is the occurrence, at Mount Browne and at Tibooburra, of auriferous drifts of Cretaceous age. This occurrence was, I think, first noticed by the late Mr. C. S. Wilkinson.* At the western end of Mount Browne, a rounded quartz pebble drift which has proved to be highly auriferous, and has been extensively worked on a small rise known as Billygoat Hill, dips suddenly beneath the level of the Upper Cretaceous Sandstones which surround the Mount Browne Range. This quartz pebble drift takes its rise in the Mount Browne Range (Upper Silurian) somewhere near the Four-mile Diggings, and it trends, with a gradual fall, in a more or less south-westerly direction for about four miles to Billygoat Hill, on the top of which the drift is seen to be about 3 or 4 feet in thickness, lying on rather decomposed slate rocks. From here it is evident that the old Cretaceous creek or river fell over a slate cliff, for at a distance of little more than 100 yards west the drift has been followed to a depth of 240 feet in the Mount Browne Gold-Mining Company's shaft, operations in which were discontinued owing chiefly to the strong body of water met with.

* Ann. Rept. Dept. of Mines, 1884, p. 137; and Records Geol. Sur. N.S.W., vol. i., part i., 1889.

The gold from the higher portions of this old drift has been redistributed during later times, and has been worked in shallow deposits in numbers of the small gullies heading from the Mount Browne Range.

At Tibooburra the auriferous Cretaceous drifts dip off an area of granite rocks. Another instance of gold being found in Cretaceous rocks was seen at a place called the Peak, between Morden and Tarella stations, on the Milparinka-Wilcannia road. The Peak itself is an isolated conical hill of Upper Silurian slates capped (unconformably) with Upper Cretaceous quartz and ironstone conglomerate. In the adjoining hills to the north of the Peak the conglomerate dips to the north-east under a considerable thickness of Upper Cretaceous sandstone. The tenant of the Peak Government Tank (Peter Riley) has obtained a fair amount of alluvial gold by following the ironstone conglomerate to the dip, and also by working the recent gullies which intersect it, and in which the gold has been reconcentrated.

Large areas of this north-western country, particularly to the south-east of Milparinka, are covered by what are known as sandhills and claypans. The sandhills are formed by the action of the wind in heaping up the sand derived from the Upper Cretaceous sandstones. The occurrence of the claypans which alternate with the sandhills is peculiar. They consist of depressions in the surface from a few inches to perhaps 3 feet in depth, and varying in diameter from about 50 feet upwards. Each claypan has a flooring of impermeable clay. Many of these claypans are almost perfectly circular, while others have the form of long channels of regular width. It seems probable that they owe their origin to the whirlwinds (the "Burramugga" of the blackfellows) which are of such common occurrence in this country. Many of the whirlwinds remain stationary for a considerable time, which would account for the formation of the circular depressions, while others travel for considerable distances, and may thus scoop out the long channels just alluded to. The depressions having once been formed, subsequent rains carry into them water having in suspension a very small amount of finely divided clay derived from the surrounding soil. When the water is afterwards evaporated by the sun's heat, a fine coating of clay is left on the floor of the depression; and frequent repetitions of this process leave a thick floor of clay, forming a hard and impervious bed for the water.

9.—ON THE PRESENT STATE OF OUR KNOWLEDGE OF THE OLDER TERTIARIES OF SOUTHERN AUSTRALIA.

By G. B. PRITCHARD, Lecturer in Geology, Working Men's College, Melbourne.

In this paper I wish to give a sketch of the various opinions which have been held by various writers on the Tertiary geology of the southern parts of Australia, and the evidence, as far as can be gathered, for the expression of those opinions.

By the term "Older Tertiary" it is usually understood in the European area that beds of Eocene age only are indicated; but in Australia, on account of the comparatively poor development of the marine Pliocene beds, and the great development and geographical association of our marine Miocene and Eocene deposits, it has become the practice to associate the two latter under the name of Older Tertiary.

LOCALITIES.

VICTORIA.—Snowy River to the neighbourhood of Port Albert, including Lake Tyers, Jemmy's Point, Bairnsdale, Mitchell River, Longford, Merriman's Creek, and Woodside; Flinders; Port Phillip, including Mornington (sometimes called Schnapper Point or coast between Mount Eliza and Mount Martha), and Beaumaris (sometimes called Cheltenham or Mordialloc); South Yarra; Royal Park; Keilor; Newport (shaft and bore); Altona Bay (bore); Duck Ponds Creek (bore); Geelong district, including Corio Bay, Waurn Ponds, Barwon and Moorabool Valleys, Shelford, Murghebuloc, Maude, Belmont, Curlewis, Connewarre, and Spring Creek to Loutit Bay; Birregurra; Cape Otway; Aire River; Gellibrand River to Port Campbell and Curdie's Inlet; Camperdown (Lakes Bullen Merri and Gnotuk); Warrnambool; Portland; Muddy Creek; Glenelg River; Edenhope; Stawell (Welcome Rush, Glenorchy), ?? Violet Town; underlying the plains of the Wimmera district.

SOUTH AUSTRALIA.—Mount Gambier; Murray River from Lake Alexandrina to Overland Corner; St. Vincent Gulf, Aldinga (Port Willunga), Onkaparinga, and Hallett's Cove; Stansbury, Port Vincent, and Edithburg; Great Australian Bight.

TASMANIA.—Table Cape on the north-west coast; also isolated patches occur fringing the northern coast and the islands in Bass Strait, notably near Cape Grim, and Heathy Valley, Flinders Island.

WESTERN AUSTRALIA.—Low coastal cliffs between Geraldton and Sharks Bay; Great Australian Bight and for 150 miles inland.

NEW SOUTH WALES.—Arumpo Bore.

HISTORICAL.

The observations of such early explorers as Peron, Sturt, and Strzelecki should not be wholly overlooked, though their conclusions do not tend to throw any valuable light upon the subject at present under consideration. As far back as 1854 Sir A. R. C. Selwyn, then Government Geologist for Victoria, furnished a report,* in which, dealing with the Mornington beds, he states: "Both the clay and limestone are very rich in fossil remains, and both in general lithological character, mineral and organic contents bear a striking resemblance to the clay and associated calcareous nodules of the London and Hampshire Basins." In the same year Sir A. R. C. Selwyn presented to the Royal Society of Tasmania a collection of fossil shells from Mornington; and the secretary, in acknowledging the donation, states† that "the fossils are identical in several instances with shells which occur in the cliffs between the Inglis River and Table Cape on the north coast of Tasmania, described by Count Strzelecki as a raised beach, and resemble the fossils of the Paris Basin and London Clay."

* Report on the Geology, Palæontology, and Mineralogy of the country situated between Melbourne, Western Port Bay, Cape Schanck, and Point Nepean, accompanied by a geological map and sections. Parl. Papers 1854-55, vol. i.

† Proc. Roy. Soc. Tas., 1854, p. 169.

In a report* two years later Sir A. R. C. Selwyn recognises equivalents of Pleistocene, Pliocene, Miocene, and Eocene in Victoria, and records several genera from the Eocene beds. Mr. William Blandowski was also early in the field, as his report† was written in December, 1854, though it does not appear to have been published till 1857. He records the occurrence of several genera of cephalopods, gastropods, lamellibranchs, and polyzoa from the beds near Mount Martha, and states as his opinion that they belong "to the Upper Tertiary formation, and coeval with the uppermost strata of the London, the Paris, Vienna, and different Italian clay basins."

In 1859 the Rev. J. E. Tenison Woods‡ describes the Tertiary rocks of the Mount Gambier district, and regards the polyzoal limestone there as of Eocene age; subsequently§ he advocates a younger age, and thinks the beds will eventually prove identical with the Coralline Crag at home, but later still|| he thinks the beds older than the Coralline Crag, but younger than the Muddy Creek beds.

In 1861¶ Sir F. McCoy stated his belief that the beds between Mount Eliza and Mount Martha were Upper Eocene, though the term Oligocene is now used by him instead, to be in accord with the later classification adopted in Europe. In the same publication** Sir A. R. C. Selwyn retains the same subdivision of the Tertiary rocks of Victoria as that indicated by him in 1856. In 1865 Mr. C. S. Wilkinson reported on the country between Apollo Bay and the Gellibrand River,†† and was, I believe, the first to investigate these coastal deposits, and to obtain fossils from the latter locality, which he regarded as Miocene. In 1866,‡‡ in his essay on the Recent Zoology and Palæontology of Victoria, and under the heading of Miocene Period, Sir F. McCoy states: "These have the general facies and even specific identity of so many species so clearly marked that there cannot be the slightest doubt of the great thickness of those beds being Lower Miocene of the date and general character of the Faluns of Touraine, the Bordeaux and the Malta beds; while the base of the series blends imperceptibly with a series of beds having a slightly older facies, and rendering the adoption of the Oligocene formation of Beyrich as convenient for Victorian as for European geologists."

In the same publication Sir A. R. C. Selwyn, in his essay on the Geology of Victoria,§§ states of our Tertiary beds: "They include groups of strata of earth, loam, sand, clay, gravel, conglomerate, ferruginous and calcareous sandstone and grits, hard quartz rock, marble, and other kinds of limestone, and various volcanic products, each of which has its more or less distinctive geological, palæontological, or mineral character, indicating it to be truly representative of the

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* Report on the Geological Structure of the colony of Victoria, the Basin of the Yarra, and part of the northern, north-eastern, and eastern Drainage of Western Port Bay. "Votes and Proceedings," Legislative Council, 1855-56, vol. ii.

† Report II. to the Hon. the Surveyor-General. On an excursion to Frankston, Balcomb's Creek, Mount Martha, Port Phillip Heads, and Cape Schanck. Phil. Trans. Vic., vol. i., 1857, p. 24 *et seq.*

‡ Q.J.G.S., vol. xvi., p. 253 *et seq.*

§ Geo. Obs. in S. Austr., 1862, pp. 85, 86.

|| Q.J.G.S., 1865, vol. xxi., p. 393.

¶ Exhibition essays, 1861, p. 159.

** *Id.* p. 181.

†† Parl. Papers, 1865, map in Parl. Papers, 1866, second session, vol. ii.

‡‡ Exhibition essays, 1866, p. 322 or p. 17.

§§ *Id.* p. 165 or p. 21.

recognised Eocene, Miocene, Pliocene, or Pleistocene (including recent) deposits of Europe and other countries; the terms being applied here, however, simply to denote Lower, Middle, Upper, and Recent Tertiaries, rather than either exact synchronism with European beds or any ascertained relative percentage of living and extinct forms in their fossil contents."

In 1868 the same author wrote a Descriptive Catalogue of the Rock Specimens and Minerals in the National Museum collected by the Geological Survey of Victoria, and includes, besides an immense amount of valuable information, a comparative tabular arrangement between the British and Victorian stratified rocks.

Mr. R. Brough Smyth, in 1873,* gives a tabular view with lithological description of the then known principal deposits representing the main divisions of the Tertiary. He follows Sir F. McCoy in regarding Schnapper Point or Mornington as Oligocene and as the lowest beds of the Tertiary series.

In 1874 the First Progress Report of the Geological Survey of Victoria was issued by Mr. R. Brough Smyth, then Secretary for Mines, and in it is included a list of Victorian Tertiary fossils furnished by Sir F. McCoy. This list† contains thirty-two species under the head of Oligocene (Schnapper Point), thirty-five species under Miocene, and thirteen species under Pliocene and Post-Pliocene, and is the only one I am aware of that has been published by Sir F. McCoy. Further remarks on this I will defer till dealing with the basis of classification for Tertiary beds. Included in this volume is a report written in 1873 by Mr. F. M. Krausé on the country between Jan Juc and Apollo Bay,‡ in which he regards the coastal Tertiaries there as of Miocene age. In the same year Professor G. H. F. Ulrich published a valuable Descriptive Catalogue of the Rocks of Victoria, with important geological notes,§ in which he closely adheres to the previous work done by Sir A. R. C. Selwyn.

In 1875 Mr. A. W. Howitt gives us much valuable information on the stratigraphical relationship of the Tertiaries of Gippsland.‖

In 1876 the Rev. J. E. T. Woods,¶ in speaking of the Table Cape fossils, states: "Though some of the shells, as far as yet known, are peculiar to the Table Cape beds, and many of the corals, yet the majority of the fossils are identical with those of the Australian so-called Miocene, and undoubtedly belonging to the same sea." During the same year Mr. R. A. F. Murray, reporting on the Geology and Mineral Resources of South-western Gippsland** under the head of Tertiaries, remarks as follows:—"As pointed out in Mr. Brough Smyth's Progress Report for 1874, the insufficiency of our palæontological evidence prohibits the absolute identification of the Tertiaries of this country with their supposed European equivalents, and the terms Miocene and Pliocene are here merely used provisionally as applied to the Tertiaries of Gippsland to express the relations of the beds to one another."

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* Internat. Exhib., 1873. Essay on Mining and Mineral Statistics, pp. 12 and 13.
† Prog. Rep. Geo. Surv. Vic., vol. i., p. 33; and Parl. Papers, 1874, vol. ii., p. 21.
‡ *Id.* Appendix A, p. 99.
§ Report of the Trustees of Public Library. Parl. Papers, 1874, vol. ii.
‖ Prog. Rep. Geo. Surv. Vic., vol. ii., p. 59 *et seq.*
¶ Proc. Roy. Soc. Tas., 1876, p. 92.
** Prog. Rep. Geo. Surv. Vic., vol. iii., p. 146.

In 1877 the same writer separates the coastal Tertiaries of the Cape Otway or Gellibrand district* into Middle Tertiary (Miocene) and Lower Tertiary (Oligocene).

In 1878 Professor R. Tate† divides the Aldinga beds into Miocene and Eocene, and classes Muddy Creek as Miocene; and later on in the same publication‡ indicates an Upper, Middle, and Lower Marine series in the beds of the River Murray Cliffs, and states the Upper Murravian series to be the direct equivalent of the Muddy Creek beds.

In 1879 the same author gives a table in which he correlates the various South Australian representatives of Tertiary time.§

In 1880 Sir James Hector attempts a correlation of some of the Australian Tertiaries with those of New Zealand.||

In 1881 Professor R. Tate restricts Upper Murravian to the oyster banks, and in consequence correlates the Muddy Creek beds with the Middle Murravian.¶

In 1887 Mr. R. A. F. Murray concentrates the work done by the Geological Survey of Victoria, and retains the beds at Schnapper Point and the mouth of the Gellibrand as Oligocene, and the oldest of our Tertiary series.**

In 1888 Mr. R. M. Johnston, in his Geology of Tasmania, includes all the Tertiary rocks of Tasmania under the two heads—Palæogene and Neogene. In 1888 Mr. J. Dennant divides the Muddy Creek beds into two series; the lower he calls Eocene, and correlates it with the Mornington beds, and of the upper he thinks it improbable that they are older than Miocene.†† Two years later the same author‡‡ refers the beds at Jemmy's Point, Gippsland, to the same horizon as the upper beds at Muddy Creek—viz., Miocene—and the limestones and sandy beds of Bairnsdale and the Mitchell River to Eocene. In 1891 Mr. T. S. Hall and myself showed that the Miocene of the Geological Survey of Victoria, as represented by the Waurn Ponds and Batesford limestones in the Geelong district underlie their Oligocene, as represented by the Orphanage Hill clays and other similar outcrops higher up the Moorabool Valley, the whole series being called Eocene by us.§§

During the same year Mr. H. P. Woodward, Government Geologist for Western Australia, doubtfully indicates the occurrence of Eocene and Pliocene deposits in Western Australia,|||| but in his latest report¶¶ he speaks with certainty on their occurrence.

In 1892 I wrote an article entitled, "Remarks on the Tertiaries of Australia," together with a catalogue of Tertiary fossils, which included 258 Miocene species and 842 Eocene species.***

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* Prog. Rep. Geo. Surv. Vic., vol. iv., p. 130-132.
† Phil. Trans. Adelaide, 1878, p. 90 *et seq.*
‡ *Id.* p. 120 *et seq.*
§ *Op. cit.*, 1879, p. liii.
|| Proc. Roy. Soc. N.S.W., vol. xiii., p. 70 *et seq.*
¶ Trans. Roy. Soc. S.A., 1884, p. 10.
** Geo. and Phys. Geog. Vic., p. 101 *et seq.*
†† Trans. Roy. Soc. S.A., vol. vi., p. 30 *et seq.*
‡‡ Proc. Roy. Soc. Vic., vol. iii., n.s., 1891, p. 53 *et seq.*
§§ Proc. Roy. Soc. Vic., vol. iv., n.s., 1892, p. 16.
|||| Ann. Rep. Govt. Geologist for 1890, Perth, 1891, p. 12.
¶¶ Mining Handbook to Western Australia, Perth, 1894, p. 31.
*** Ann. Rep. S.A. School of Mines and Industries, 1892, p. 171.

In 1893 Mr. T. S. Hall and myself, in describing the Eocene beds of the Bellarine Peninsula,* showed the "Older Basalt" (Miocene) of the Geological Survey to underlie their Oligocene, as represented by the clays of Curlewis†; the latter we showed to be Eocene, and consequently the "Older Basalt" must be Eocene or older. In the same year Professor Tate and Mr. Dennant wrote a paper entitled "Correlation of the Marine Tertiaries of Australia,"‡ in which they refer the beds at Spring Creek, Muddy Creek, Gellibrand River, Camperdown, Mornington, and Cheltenham, to Eocene; upper beds at Muddy Creek, Jemmy's Point, Portland, and the Glenelg River to Miocene. Later still in the same year Professor R. Tate, in his presidential address to the Australasian Association,§ gives a table of the component systems of the Cainozoic of Australia, besides a vast amount of other valuable matter.

In 1894 a paper on the Older Tertiaries of Maude, with an indication of the sequence of the Eocene Rocks of Victoria,|| was written by Mr. T. S. Hall and myself, and this is, I believe, the first attempt of the kind made since the adoption of the new classification of the Older Tertiaries. The Older Basalt of that district is proved to be of Eocene age. The latest volume of the Progress Reports of the Victorian Geological Survey, only just issued,¶ contains a valuable contribution to our knowledge in "Notes on the Geological Features of an Area in South Gippsland," by Mr. J. H. Wright, in which the sequence of seven distinct sets of beds has been carefully worked out upon stratigraphical evidence; but the author, in the absence of reliable palæontological evidence, cautiously refrains from attaching definite ages to the beds.

REMARKS ON THE FAUNA.

By far the commonest forms of life in our Tertiaries are Mollusca and Brachiopoda, and we are indebted chiefly to Professor R. Tate for the elaboration of the species, for he has already published one part on the brachiopods, two parts on the lamellibranchs, and four parts on the gastropods, besides several other papers including representatives of these and other fossils. Sir F. McCoy at one time stated** that many species of mollusca were "identical with extinct species of the same geological age in other localities both in Europe and North America"; but subsequent examinations have shown this to be incorrect, and I can safely assert that at present we do not know amongst the mollusca a single example of a European or North American fossil. From this it can be seen, as has recently been asserted by Sir F. McCoy,†† that the fauna is a characteristically Australian one, and on this account I fail to see what good can come of comparing with so-called European or American equivalents to prove or disprove the

* Proc. Roy. Soc. Vic., vol. vi., n.s., 1894, p. 1.
† Prod. Pal. Vic., Dec., iv., p. 26.
‡ Trans. Roy. Soc. S.A., vol xvii., 1893, p. 203.
§ A.A.A.S., Adelaide, 1893, p. 65.
|| Proc. Roy. Soc. Vic., vol. vii., n.s., p. 180.
¶ Prog. Rep. Geo. Surv. Vic., vol. viii., 1894.
** Exhib. Essays, 1866, Recent Zoology and Palæontology of Victoria, p. 17.
†† Prog. Rep. Geo. Surv. Vic., vol. viii., 1894, p. 48.

age assigned to the Australian beds. In some of the other forms of life which are admittedly more widely distributed, such as the fish (sharks, &c.), we may gather a large amount of useful and interesting information, but this evidence should not be regarded as more overwhelming than that obtained from other more reliable sources. One remarkable feature of the mollusca is the fact that two or three of the commonest forms are identical with living species, and great stress has apparently been laid upon this by Sir F. McCoy for classification purposes.* It is probably partly due to this fact that erroneous ages have been attached to so many of our Tertiary beds, for in the earlier days when, so far as published accounts go, so few fossils were known, it would be very easy to lay more stress upon the relatively much greater abundance of two or three living species than is possible at present in view of the enormously greater number of extinct species now known.

The polyzoa are exceedingly abundant at all the sections, and have been fully worked out by Dr. P. H. MacGillivray, of Bendigo, whose magnificent monograph on this group of our Tertiary fossils came before the Royal Society of Victoria at its December meeting, 1894. This valuable work contains much new matter, and we shall not now have to wait long before it is published in a style worthy of the labour involved in its preparation. Some of our beds are very rich in echinoderms, but these fossils are not restricted to one horizon, and therefore more care will have to be taken than has hitherto been done in some cases in recording the exact locality from which the fossils were obtained, otherwise much needless confusion and difficulty will arise. Much has been written on these forms by Dr. Laube, Rev. J. E. T. Woods, Mr. R. Etheridge, Junr., Professor P. M. Duncan, Mr. J. W. Gregory, Mr. A. Bittner, and Professor R. Tate, and much has been said about the survival of Cretaceous genera and the occurrence of genera belonging to the Nummulitic of Europe and India, and of genera belonging to recent time, but no successful attempts have been made to classify our Tertiary beds upon these fossils.

For our information about the corals we are indebted principally to Professor P. M. Duncan and the Rev. J. E. T. Woods. The former found them to be mostly extinct and peculiar species, and did not see his way clear to suggest any subdivision of the Tertiaries based upon this class. This is not to be wondered at when, upon examination of the localities from which he records his species, they all prove to be Eocene, and not in some cases Miocene and in other cases Oligocene, as indicated to him by the Geological Survey of Victoria. On this point Professor Duncan states†: "The species of the different beds have so great a general and exact resemblance that they do not offer evidence of any great biological changes having occurred during the deposition of the whole of the fossiliferous Tertiary sediments. It is therefore not consonant with the rules of classificatory geology to subdivide the sediments into such a series as Oligocene, Lower, Middle, and Upper Miocene and Pliocene, which for the most part have very distinct faunas in the European area."

* Exhib. Essay, 1866, Rec. Zoo. and Pal. Vic., p. 17; also Prog. Rep. Geo. Surv. Vic., vol. viii., 1894, p. 48.

† Q.J.G.S., vol. xxvi., p. 284 *et seq.*

The foraminifera have been well examined by Mr. W. Howchin, who expresses* his ability to recognise different horizons which agree with those now generally held, and have been based upon stratigraphical and molluscan evidence.

BASIS OF CLASSIFICATION.

All the early attempts at classifying our Tertiaries seem to have been based upon lithological grounds in conjunction with general facies. The result of such work, as would naturally be expected, proves upon critical examination to be inconsistent with itself, and this probably accounts in the main for much of the erroneous sequence indicated by the ages attributed to various beds in Victoria. Sir F. McCoy furnished the list, already noted, of Tertiary fossils in 1874, containing thirty-two Oligocene species, of which twenty-two are mollusca proper; and thirty-five Miocene species, of which nine are mollusca proper. Included among the twenty-two Oligocene species are three living shells which give a percentage of 13·6, and amongst the nine Miocene species are the names of four living species, giving a percentage of 44·4. This seems rather a remarkable coincidence, but it is hardly likely that such an authority as Sir F. McCoy would base his arguments upon such slender evidence. By taking these lists as they stand, and checking them in view of our present knowledge of the species indicated, we find that the percentage of the Oligocene beds reduces to five, and that of the Miocene beds to about ten. Somewhat later (1876) Mr. R. A. F. Murray deplores the fact that the insufficiency of our palæontological evidence prohibits the absolute identification of the Tertiaries of this country with their European equivalents, and states that the terms he uses are provisional, and merely intended to express the relations of the beds to one another. At the present time this cannot be stated, for we now know between 1,000 and 2,000 species from the Older Tertiaries, and of these quite 1,000 species are diagnostically known; and as far as the examination of the remainder has gone, it fully bears out and confirms the conclusions based upon the already known species. With such an amount of material as this, made up principally of mollusca, we are in a position to apply the percentage principle of living to extinct mollusca, as laid down by Sir C. Lyell with equal value and accuracy in these colonies as in Europe or America. This principle, taken in conjunction with the stratigraphical relation and succession of the beds, seems to me to be the only correct way in which to classify Tertiary deposits.

As already pointed out, many seem to rely greatly upon facies, and this must be what Sir F. McCoy means by stating during last year† that he has not yet seen any true Eocene strata in Victoria, also by stating in the same report‡ that the Geological Survey of Victoria may safely accept on his authority that the Muddy Creek and Schnapper Point beds are "of newer date than any true Eocene Tertiary type, such as the London clay of the south-east of England, or the corresponing part of the basin of Paris." Professor R. Tate has

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* A.A.A.S. Adelaide, 1893, p. 352 *et seq.*
† Prog. Rep. Geo. Surv. Vic., vol. viii., 1894, p. 47.
‡ *Id.* p. 48.

also used facies in determining the age of the sands of the Dry Creek and Croydon bores to be Older Pliocene. He records 210 molluscan species, and has worked out the percentage of living to extinct forms as about twenty-seven. He states, however,* that he is "fully aware that the proportion of living species is too low to justify its employment as measured by the European standard; yet in this case the percentage principle of classification does not adequately express the modern complexus of the whole fauna." If facies as applied to the mollusca of Tertiary beds is so important in some cases as to make the percentage principle as flexible as this, why is facies so often wholly neglected, and the percentage system of classification so rigidly adopted?

Mr. J. Stirling, in his "Notes on a Recent Classification of the Older Marine Tertiary Beds of Victoria,"† states that the beds "show a high percentage of forms said to be referable to an Eocene facies." This remark is very misleading, and is most certainly not the basis upon which our beds are classed as Eocene.

Sir F. McCoy also states in a recent report‡ that "the percentage of recent mollusca is far higher than in any such recognised Eocene sections (London clay, Barton beds, and Paris basin)"; but I have been quite unable to find any definite statement of the exact, or even approximate, percentage of living forms in any of our Victorian beds in Sir F. McCoy's publications, or in those of the Geological Survey or Mining Department of the colony, with the single exception of the implied instance above considered.

In the same report the polyzoa are said to amply bear out his original determination, but it is only very recently§ that the more definite statement has been made that 12 per cent. of these organisms are living species. There is evidently some mistake here, for Dr. MacGillivray, in his monograph, sets down the percentage of recent species at 35·6, based upon the whole of the species he has recognised from the various beds from which he has hitherto had material. No cognisance has, however, been taken of the fact that two distinct beds, Eocene and Miocene, occur at Muddy Creek, and on that account we are not yet aware whether any appreciable difference is noticeable between the polyzoa of these two horizons. He also stated that some authorities separate the beds into Oligocene and Miocene, whereas others regard them as Eocene; but the polyzoa, as far as yet examined, clearly indicate that the beds from which they have been obtained are of one and the same age.

In the discussion ensuing upon Dr. MacGillivray's paper, he stated that he did not regard the polyzoa as of any importance in determining the ages of our Tertiary beds, and that, so far as he was aware, no attempt to use these fossils for classification purposes had been made in Europe.

Professor P. M. Duncan, in his papers on our fossil echinodermata, evidently experienced the same difficulty in understanding the subdivisions of our Tertiary beds by the Geological Survey of Victoria as

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* Trans. Roy. Soc. S.A., 1890, p. 178.
† Prog. Rep. Geo. Surv. Vic., vol. viii., 1894, p. 48.
‡ Ann. Rep. Dept. of Mines Vic., 1893, p. 19.
§ Prog. Rep. Geo. Surv. Vic., vol. viii., 1894, p. 48.

when dealing with our fossil corals, for he says*—"The general facies of the whole is older than is warranted by the geological position." Mr. J. W. Gregory, from his examination of the echinoderms, regards the evidence to be gathered from them in favour of the Eocene age of the beds in which they occur.†

Professor P. M. Duncan, in 1870, in dealing with our Tertiary corals, after showing that they did not in any way confirm but actually conflicted with the subdivisions of our Tertiary beds adopted by the Geological Survey of Victoria, says‡—"The diagnosis of the age of the Tertiary beds by the percentage system cannot as yet be applied to the Australian sedimentary beds, in consequence of the Mollusca not having been sufficiently studied; and the comparison between the existing Australian coral fauna and that of the Tertiaries would give a much older geological age to them than is warranted by the physical geology of the area."

Mr. R. M. Johnston, in 1876,§ regarded any attempt at classifying the beds at Table Cape as premature and misleading, as sufficient was not known of either the existing or extinct forms, and advises the acceptance with the greatest caution of "the subdivisions of the various widely separated Tertiary marine deposits of Victoria into Oligocene, Miocene, and Pliocene until we know more fully the extent and quality of the evidence which forms the basis of their classification." Even in 1888 Mr. Johnston, in his "Geology of Tasmania," did not see his way clear to adopt any more definite subdivision for the Tasmanian Tertiaries than that indicated by the use of such terms as Palæogene and Neogene.

As already pointed out, the evidence from the foraminifera in no wise conflicts but confirms that now advocated upon the molluscan percentage principle and stratigraphical succession of the beds.

SUCCESSION OF THE BEDS.

Sir F. McCoy and the Geological Survey of Victoria have always regarded the blue clays of Mornington and the Gellibrand River, and their equivalents in other parts of the colony, as of Oligocene age and the oldest members of the Tertiary series in Victoria.‖

Professor Tate and Mr. Dennant in their correlation paper¶ also state that Mornington "is correctly placed at the base of the Tertiary series."

Mr. T. S. Hall and I have shown that in the Geelong district the polyzoal limestone called Miocene by the Geological Survey really underlies the clays called by them Oligocene, and we regard both as Eocene.**

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* Q.J.G.S., vol. xxxiii., p. 69. † Geo. Mag. N.S., Dec. III., vol. vii.

‡ Q.J.G.S., vol. xxvi., pp. 313, 314. § Proc. Roy. Soc. Tas., 1876, p. 89.

‖ Exhib. Essay, 1866, McCoy, p. 332 or 17; Prog. Rep. Geo. Surv. Vic., vol. i., 1874, p. 35; *op. cit.* vol. iv., pp. 132, 157; *op. cit.* vol. v., pp. 23, 176; Prod. Pal. Vic. Dec. I. to VII.; Geo. and Phys. Geog. Vic., p. 101; Prog. Rep. Geo. Surv. Vic. vol. viii., 1894, p. 48.

¶ Trans. Roy. Soc. S.A., 1893, p. 216.

** Proc. Roy. Soc. Vic., vol. iv., n.s., p. 16.

Lately we have shown that the Survey is entirely wrong in the sequence they indicate by the ages they have assigned to the various beds, as we find in the Maude district beds equivalent to the lower beds of Spring Creek underlying the "Older Basalt," and those equivalent to Waurn Ponds overlying the "Older Basalt."* In addition to this stratigraphical evidence we indicate the occurrence of 293 molluscan species at the Spring Creek section, and of these only three are living species; therefore there is practically only 1 per cent. of living species in these beds. In the same paper we work out the percentage for the Lower Muddy Creek beds, with the result that about 2·5 per cent. are living species, which clearly indicates an horizon younger than that of Spring Creek, yet not too young to be called Eocene. We have also recorded† 150 species from Curlewis, and of these only three are living species, so that there is only 2 per cent. of the latter in these beds so far as the examination of them has yet gone. There is also little doubt as to the identity of the Curlewis and Belmont beds, as many hitherto peculiar species are obtained from these beds, and the remainder of the fauna is made up in part of some hitherto characteristic forms of the Spring Creek horizon, in part of hitherto characteristic forms of the Mornington horizon, and in part of species common to both horizons. Upon the foregoing evidence I am inclined to regard the Curlewis and Belmont clays as indicating an horizon intermediate between that of Mornigton and that of Spring Creek.

Mr. R. A. F. Murray has stated of the "Older Basalt" that it marks "distinctly the close of the Middle Tertiary or Miocene era,"‡ and this expresses the view held by the Survey, but it has now been shown to underlie the Eocene clays of Curlewis§—that is, the Oligocene of the Survey—also to underlie the Eocene limestones of Flinders and the Eocene at Eagle's Nest on the Otway Coast; but the conclusive section for determining the age of the "Older Basalt" occurs at Maude, where, as already noted, we have marine Eocene beds underlying as well as overlying the volcanic rock, and therefore it must be of Eocene age. The upper part of the Moorabool Valley in the neighbourhood of Maude was the district in which Sir A. R. C. Selwyn originally determined the age of the "Lower Gold Drifts" to be Miocene. This age was then generally applied in other localities where the drift was overlaid by the "Older Basalt," as in Gippsland, &c. Now that the age of the volcanic rock has been altered it will also be necessary to place our "Lower Gold Drifts" further back in time. The same remarks apply to the various plant-bearing beds which have been proved to underlie the "Older Basalt."‖

In Gippsland, in the valley of the Narracan Creek, it is interesting to note that an important seam of brown coal occurs underneath the "Older Basalt."¶ A seam of brown coal 70 feet in thickness, and underlying marine Eocene beds equivalent to those at Mornington, has also been passed through in the Altona Bay bore, about twelve or thirteen miles from Melbourne.

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* Proc. Roy. Soc. Vic., vol. vii., n.s., p. 180 *et. seq.*
† Proc. Roy. Soc. Vic., vol. vi., n.s., p. 10.
‡ Geo. and Phys. Geog. Vic., p. 109.
§ Proc. Roy. Soc. Vic., vol. vi., n.s., p. 2.
‖ A.A.A.S. Adelaide, 1893, p. 338 *et seq.*
¶ Prog. Rep. Geo. Surv. Vic., vol. viii., p. 28.

The term "Newer Basalt" of the Survey is somewhat misleading, as it seems almost certain that there are several distinct basaltic flows newer than that regarded in this paper as Eocene, and this is indicated by the old survey by the use of such terms as "Upper Newer" and "Lower Newer." We can, however, arrive at something like the age of the basalts of the Werribee Plains, Geelong, and Camperdown, for they are overlaid by, and therefore older than, the beds containing our fossil marsupials; the latter being usually regarded as of Pliocene age, it is probable that the above basalts may also belong to that period. These flows are clearly anterior to the volcanic ash-beds of Mount Gambier, for the latter are stated by Professor R. Tate to overlie deposits of the Diprotodon Period.*

The ages of many of our Victorian gold-drifts are somewhat difficult to fix in the absence of palæontological evidence, the only deposits of this nature from which a fossil fauna has been recorded being the gold-drift of Dunolly, from which remains of *Phascolomys pliocenus*, McCoy, have been obtained, and the gold-drift of the Loddon River, south-west of Maldon, which has yielded remains of *Sarcophilus ursinus*, and therefore the age is set down as Pliocene.

SUMMARY.

Perhaps the best method to summarise the foregoing results will be to give three tables indicating the various beds and the ages to which they have been assigned; first, according to Sir F. McCoy and the Geological Survey of Victoria; second, according to Professor R. Tate and Mr. J. Dennant, as tabulated in the presidential address to the Adelaide meeting of the Australasian Association for the Advancement of Science; third, according to Messrs. T. S. Hall and G. B. Pritchard.

TABLE I.—GEOLOGICAL SURVEY OF VICTORIA.

TERTIARY OR CAINOZOIC.

Post-Tertiary.—Recent creek and river deposits, forming alluvial flats; sand dunes; recent sands, clays, gravels, and estuary beds, forming surface deposits of plains bordering the Murray River, from the Ovens to the Western boundary of the colony. Sale Plains; Alberton; Plains between Werribee and Little River.

Upper Tertiary (Pliocene).—Ferruginous sandstones with marine shells, Geelong, Flemington, Brighton, Cheltenham, and Stawell; quartz gravels of the Flagstaff Hill, Melbourne, Haunted Hill, Tom's Cap, and Longford to Woodside in Gippsland, northwards from Stawell towards the Wimmera River; freshwater limestones, Geelong; leaf-beds of Daylesford and Malmsbury, Ballarat, Creswick, and Haddon Leads; sandy marls at Jemmy's Point, Gippsland Lakes; newer basalts.

Middle Tertiary (Miocene).—White clays with impressions of leaves beneath the older volcanic, Flemington, Berwick; ferruginous beds, with fossil flora, Pentland Hills (Bacchus Marsh), Dargo and Bogong High Plains; auriferous gravels, Dargo High Plains, Tanjil, and Russell's Creek; older volcanic rocks; fossiliferous, sandy, and

* A.A.A.S. Adelaide, 1893, p. 69.

calcareous beds on the coast between Warrnambool and Cape Otway, and between Loutit Bay and Geelong (Spring Creek), Moorabool River, Leigh River, Bairnsdale, Gippsland Lake's entrance, Longford and Merriman's Creek, near Sale, Curdie's River, and other localities; lignites, McKirley's Creek, north of Crossover and Tarwin River, near McDonald's track; calcareous beds underlying the Upper Tertiary of the plains bordering the Murray; siliceous conglomerates and quartzites underlying older volcanic rocks, Gippsland.

Lower Tertiary (Oligocene).—Grey clays, with septaria, near Schnapper Point, and mouth of the Gellibrand River, also grey clays at Orphanage Hill or Fyansford, Geelong, Shelford (Ad. 14), referred to as Outer Geelong Harbour or parish of Moolap or Curlewis, and Muddy Creek near Hamilton.

TABLE II.—PROFESSOR R. TATE AND MR. J. DENNANT, 1893.

CAINOZOIC.

Pleistocene.—Raised beaches. Æolian calciferous sandstones and limestones.

Post-Pliocene.—The newer basalts and ash-beds of Victoria; the ash-beds of the Mount Gambier area, South Australia, overlie deposits of the Diprotodon Period.

Newer Pliocene.—Elevated shell beds—south-east from Mount Gambier and at Limestone Creek, West Victoria. Osseous breccias and mammaliferous drift of the Diprotodon Period.

Older Pliocene.—Marine sands beneath mammaliferous drift of the Adelaide Plain.

Miocene.—Upland Miocene plant beds, South Australia; low-level marine beds—Gippsland Lakes, upper beds of the Muddy Creek section, oyster banks of the River Murray Cliffs, and Aldinga Bay.

Eocene.—Clays and polyzoal limestone—Mount Gambier, Rivers Mitchell, Tambo, &c.; Sale, Gippsland; Port Phillip Bay; around the carbonaceous area of Cape Otway; Camperdown; Muddy Creek, Hamilton. Polyzoal limestone—Mount Gambier, River Murray, St. Vincent Gulf, Great Australian Bight. Plant beds at Vegetable Creek, New South Wales—plant beds inferior to the older basalts of Victoria.

Pre-Eocene.—The older basalts of Southern Victoria.

TABLE III.—MESSRS. T. S. HALL AND G. B. PRITCHARD, 1895.

TERTIARY OR CAINOZOIC.

Recent.—Raised beaches; estuary beds; alluvial deposits; travertine deposits; sand-dunes and Dune Limestones of the coast.

Pliocene.—Limestone Creek beds, south-west Victoria, containing about 80 per cent. of living mollusca. Volcanic ash-beds of Mount Gambier. Mammaliferous sandy clays containing Diprotodon, &c., of Adelaide Plain, and many other South Australian localities, Werribee Plains, Colac, Camperdown, &c., in Victoria, also in New South Wales and Queensland; mammaliferous cave deposits of New South Wales and Victoria; freshwater limestones of the Geelong district; gold-drifts of Dunolly. Newer basalts at Werribee, Geelong, and Camperdown.

Miocene.—Marine sands of the Dry Creek and Croydon bores, South Australia. Oyster beds of the Murray River Cliffs and Aldinga Bay, South Australia. Calcareous sands and clays of Jemmy's Point, Gippsland, and the upper beds at Muddy Creek, near Hamilton, West Victoria.

Eocene (Marine series).—Generally limestones, clays, and sands from the Snowy River, Gippsland, to the Great Australian Bight, also from Geraldton to Shark's Bay, Western Australia, and Table Cape, Tasmania.

SEQUENCE.

1. *Clays of the Lower Muddy Creek Type.*—Occurring at Muddy Creek, Mornington or Schnapper Point, Lake Connewarre (Campbell's Point, &c.), Southern Moorabool Valley (Fyansford, &c.), Corio Bay, Altona Bay (bore), Newport (shaft), Gellibrand, Camperdown (Gnotuk), Birregurra, Murgheboluc, Shelford, Bairnsdale (Mitchell River).

2. *Polyzoal Limestone of the Waurn Ponds Type.*—Occurring at Waurn Ponds, Batesford, Maude (upper beds), Flinders, Airey's Inlet, (?) Muddy Creek.

Clays and Limestones of the Curlewis Type.—Occurring at Curlewis and Belmont in the Geelong district.

3. *Older Volcanic Rock.*

4. *Lower Eocene—Clays and Limestones of the Spring Creek Type.*—Occurring at Spring Creek, near Geelong, and Maude (lower beds). The equivalent of this horizon in South Australia is seen in the Lower Aldinga series, and in Tasmania the Table Cape beds probably occupy a similar position.

Lower Eocene or Upper Cretaceous.—The "Lower Gold Drifts" at Steiglitz and the Upper Moorabool Valley, Dargo High Plains, Tanjil, and Russell's Creek.

The Plant-bearing beds, as the white clays, underlying the "Older Basalt" at Flemington and Berwick, and the ferruginous beds with fossil flora at (?) Pentland Hills (Bacchus Marsh), Dargo and Bogong High Plains. The "Lower Brown Coals" of South Gippsland as in the valley of the Narracan Creek, also the brown coals of the Altona Bay bore and the Newport shaft.

The Darriwill quartzites and South Gippsland quartzites as at Ordlaw in the Narracan district.

10.—THE DEVELOPMENT AND PROGRESS OF MINING AND GEOLOGY IN QUEENSLAND.

By WILLIAM FRYAR, Inspector of Mines, Queensland.

It may have been observed from the title of this paper that I am departing somewhat from the strictly scientific aspect of the subject. As it is necessary, however, occasionally to look at the results obtained, as well as the work performed, I may be pardoned if I deal with it from a statistical and historical, rather than from a scientific, point of view. The first settlement of the shores of Moreton Bay will be within the knowledge of most of you, if not actually within the recollection of some, for it is now barely the human span of three score years and ten since the first attempt at settlement was made on the banks of the Brisbane River. The celebrated navigator, Captain Cook, had, fifty years previously, resuscitated and made seaworthy the wrecked "Endeavour" on the shores of the inlet which now bears that name, and on which stands the town known by the name of the gallant navigator, Cooktown. But that was all the settlement previous to the discovery of the Brisbane River by Oxley, in 1823, and the formation of a settlement on its banks in the following year. But for eighteen years thereafter it was a closely guarded gaol, the receptacle of the felonry of the felon population of the older and more southern capital and settlement; and, after being opened to free settlement, was for another similar period indulging in infantile prattle and adolescent indiscretion—a dependency of a dependency—until, at the close of 1859, it attained an incipient majority, and became established in December of that year as a separate and independent colony, on which Her Most Gracious Majesty was pleased to confer her own Royal title, and over which a Governor-in-Chief and Captain-General and Vice-Admiral of the same was appointed, together with all the paraphernalia of an Executive Council and two houses of Legislature.

It is difficult at any time to predict the future of the most ordinary avocations of a people who are living under usual and ordinary conditions, but much more so of those which are extraordinary, and of a people who have been transplanted to a tropical climate, and under conditions essentially different to any previously experienced. Such avocations are those required in the development of the hidden mysteries of the earth, which it is the especial province of the geologist and the miner to develop; but, whilst such development can be carried on with ease and certainty in countries with a settled population and all the means of civilisation at hand, it is quite another matter to explore a *terra incognita*, whose nerve-centre and only source of vitality is a penal settlement. Hence it will easily be believed that for the first twenty years little or nothing was done in that direction, although an extent of unexplored territory lay behind them which was beyond the conception of those whose ideas were limited by the distance of "Land's End to John o' Groats," or by "St. David's Head to Great Yarmouth," or by any other insignificant distance; for the British Empire, in the fullest extent of its home possessions, including the united dominions of the Heptarchy, the Scots, Celts, and whatever other independent islanders there may have been in the early history of mining in those islands, did not in the gross represent a tenth part of the extent of territory then awaiting development; for we had not then been "cribb'd, cabin'd, and confined" within the narrow bounds of the South Pacific and the 29th parallel of latitude and 138th meridian of longitude, but might have roamed unmolested, except by the aboriginal lords of the soil, over what is now the northern portion of New South Wales, as well as over that extensive territory lying west of our boundary, and now known as the Northern Territory of the colony of South Australia. But, even within the prescribed limits of the colony of Queensland, comprising about 428,000,000 acres, we have at the present moment 1,000 acres of land to each man, woman, and child in the colony, many of whom, indeed most of whom, can have taken no part in the exploration of its territory or in the exploitation of its mineral wealth; it will, therefore, be at once seen that what we know at present under that head is but a drop from the ocean of the Great Unknown. Ample scope is afforded for the occurrence of every description of geological formation; and, thanks to the liberal provision of our Governments in this direction, and to the indefatigable exertions of our geologists, these are gradually being examined and unfolded.

It will be understood that during the penal days of the Settlement very little was done in the direction of geological research or mineral development. The quarrying of stone, the making of bricks (probably without straw), and the burning of lime were all the handiwork of the pioneers of civilisation—those pioneers the outcasts of society; the knowledge of the processes, that possessed by their gaolers, the military subordinate officers; and the labour, that enforced by the lash and guarded by the musket. The raw material was found plentiful enough in the immediate vicinity of the Settlement and at the head of Limestone Creek, and thus a commencement was made to lay the foundations of this now prosperous colony of Queensland, and to develop, although in a feeble manner, the earliest indications of the mineral wealth which has since been proved to lie scattered over the surface, or hidden beneath the soil, in such abundance as to give to this still sparsely-populated colony a very high position among the different divisions of Australasian territory, and to promise at no very distant date to place her on the pinnacle as a producer of the most valuable of the metals—gold.

It is not on record that any other mineral was discovered during the penal days than those required in the erection of buildings such as have been already mentioned; but soon after the Settlement was thrown open to free occupation a discovery of considerable importance was made—that of coal at Redbank, on the right bank of the Brisbane River, in 1843, although it does not appear to have been worked until 1846, when the enterprise of the people created a demand for it by placing a steamer on the river to ply between the Settlement and Limestone, as Brisbane and Ipswich were then respectively called; and from that time to the present coal has been worked without intermission, but with varying success, the output having only on one occasion averaged 1,000 tons per day for each working day throughout the year, and during the past few years, whilst fluctuating near that point, it has fallen somewhat short of it. Our geologists have assured us, however, that we have abundant supplies of this mineral fuel; and although its geographical location forbids the prospect of competition with the mother colony in foreign markets, we are satisfied and gratified to be able to supply our own requirements in the various ports of the colony, as well as on our extensive railway communication from the coast to the interior, and in the manufacturing establishments and other fuel-consuming operations which are being established and carried out within its bounds.

In 1853 the Government Geologist of New South Wales (the late Mr. S. Stutchbury) in the course of his peregrinations visited the remote settlement of Moreton Bay; and during the same year the late

Rev. W. B. Clarke appears to have visited the Darling Downs also in the capacity of a geologist. The former remained two years in the district, and laid the foundation of geological research within the coastal district of what is now Southern Queensland. It does not appear that there was any further systematic geologising—at any rate, under the auspices of the Government—previous to the erection of Queensland into a separate colony; but the work of discovery was continued at the hands of the amateur geologists, who are ever with us. Coal was found at Moggill, on the left bank of the Brisbane, and at the Coal Falls above Ipswich; also outcropping in the gullies of Goodna and Bundanba. It also soon became known that deposits of ironstone existed, which with the coal and lime of Ipswich might soon do the State some service. Under present conditions, however, the working of iron is not one of the industries which has taken root or is likely to take root in the colony, where all the disadvantages of commencing a new industry are met with, where the market would be necessarily limited, and where the manufactured article can be delivered at a very small advance of price on that prevailing in the great manufacturing centres of Great Britain, and where also there are so many openings for the employment of capital that it is quite unnecessary to risk a loss by adventuring into any enterprise the success of which may be in any sense questionable.

The only other mineral or metal discovered and utilised in the pre-separation days was the noble metal, gold, and there are many old colonists who look with mingled feelings to the memorable rush to Canoona, on the Fitzroy, in 1858, when even the town of Rockhampton had not sprung into existence, and the whole district, except as to a few pioneer squatters and their employees, was a *terra incognita* to all the world. Diggers, however, with that reckless disregard of prudent precaution which was so characteristic of that nomadic class in the fifties, rushed in thousands to what was only hoped, on very meagre data, to prove an extensive alluvial goldfield, but found in many cases only disappointment, want, and misery. There was no provision for the multitude of diggers—no money to buy even if there had been food to sell—and little or no gold to be obtained by digging. It remained for the Government to step in and charter steamers to relieve the congested diggings, where only a very little gold was obtained, although it was really the parent goldfield of the colony, which during the interval since elapsed has extended and expanded its production until it now ranks on a par with Victoria, the great gold-producing colony.

We have no record of the amount obtained in those days, but in the month of December, in the year 1859, when the colony was separated from New South Wales, the amount was $24\frac{3}{4}$ oz., of the value of £87, which grain of seed has now developed into an annual production of over 600,000 oz., which it has more than averaged for the past seven years; and, judging from the production of recent years, is likely to be continued for many years to come. A marvellous development of an industry commencing at the foundation of the colony with the insignificant item abovementioned, coal being represented with 432 tons, value £289, the only other mineral production.

But geological research and mineralogical discovery followed, if it did not keep pace with, the geographical knowledge and pastoral occupation of the country; and coal, first discovered and worked at Redbank, was soon afterwards discovered and worked at Moggill, later at Tivoli, and again reopened at Redbank before the date of our separation from the mother colony, at which date the population was chiefly concentrated about Brisbane and Ipswich, districts which returned one-half of the first elective Legislature, and had much more than one-half of the entire population of the new colony. Toowoomba and Maryborough were the only other towns of importance, and pastoralists and traders constituted the bulk of the working population, for those were the days of pioneering, and in every department of industry the owner of the enterprise performed the lion's share of the work.

The great length of our coastline—about 2,500 miles—with its numerous indentations, bays, harbours, inlets, rivers, and promontories, afforded facilities for exploration and the occupation of the territory, and presented opportunities for commercial enterprise rarely equalled by continental lands, and not often surpassed by those which are completely insulated, but are wanting in the commodious harbours and extent of territory and variety of resources possessed by, and gradually being discovered in, the new and rapidly rising colony, of which only a small corner had at that time become known to the European races.

The separation of the colony of Queensland from New South Wales does not appear to have materially affected the production of mineral wealth within the newly enfranchised territory, for, although the population increased by leaps and bounds, the production of the metals, noble or useful, and of the earthy minerals remained during the first few years at a very low standard. A little gold was obtained; about 4,000 oz. during the first year, 1,000 during the second, and 190 during the third, after which the production of that metal rapidly developed into tangible proportions, for during the latter year (1862) gold was discovered at Clermont, and from that time forward Queensland has fairly taken rank as a gold-producing colony; and other minerals were discovered, and the mines bearing them developed, so that in the first five years gold to the value of £132,421 had been obtained. Coal to the value of £68,919, copper ore, beginning with one ton during the first year (1860), valued at £50, aggregated in the same time £101,832; and the only other item, building stone, a total of £21,078, so that the full value of the mineral productions of the colony during the first five years of its existence reached an aggregate of £324,250, giving an average for every month of that time equal to fifteen times the amount for that first month of December, 1859, which for coal and gold amounted to £376.

In addition to the discovery at Clermont, gold had been discovered at Thane's Creek, Warwick, and at Calliope, near Gladstone, in 1863, from each of which points a considerable quantity of alluvial gold was obtained; but these fields have not greatly developed into reefing fields. About the same time gold was discovered at Eidsvold; and although evidence was obtained of rich stone being at hand, the enterprise does not appear to have been pursued at that time, and the field was allowed to lie dormant for another quarter of a century.

The large additions to the population during those years do not appear to have influenced the production of minerals as much as might have been expected, and it was only the complete collapse of 1866 that convinced us that the slow processes of agricultural and mineral production were better for the individual and better for the State than the evil of making haste to get rich by the undue subdivision of land. We are slightly anticipating, however, as the first five years close with 1864, and we had not yet experienced the inevitable result of our mode of life. The year 1865 saw the novel addition to our list of mineral exports "quartz specimens," which may not have indicated the first discovery of auriferous quartz in Queensland, as gold had been discovered and worked at the several places above mentioned two or three years previously. The original discovery at The Springs, near Clermont, was in an ancient alluvium, a sort of cemented conglomeration. There have also been both recent alluvium and reef gold worked in the neighbourhood. At Warwick also the discovery has not been confined to alluvial, and reefs may have been discovered before the means were at hand to utilise them. Gold was discovered at the Crocodile Creek, Rockhampton district, in 1865, and here again the first gold obtained was from the alluvium, but at an early period the Hector and other reefs were opened, and it is not improbable that the first "quartz specimens" exported were from this field, as reefs were worked and the first crushing machinery erected here in 1866.

As showing that the attention of the colonists was now being directed to the mineral treasures of the earth, limestone appears in the list of productions for the first time, although that commodity had certainly been obtained at Ipswich in the pre-separation days, if not during the penal *régime* of its earliest days. But it had been found to be more practicable and economical to obtain lime by burning the shells which abounded on the shores of Moreton Bay, and whence the whole supply for the city and embryo colony was now and for many years obtained. This production of lime, however, may indicate that the supply of shells was becoming exhausted, and that building operations were extending and expanding. But for several years afterwards there is no mention of limestone, but marble appears in the following year, and continues fitfully and in small quantities until the present time. But limestone may be worked without stint in almost any part of the colony—on the coast or in the interior, on the mainland or on the islands, and much of it of a valuable quality for ornamental purposes, as marble; but polishing marble is not one of the industries promising immediate and handsome profits under the present unsettled and unsatisfactory relations of labour and capital in the colony.

No further additions accrued to our mineral productions until the crisis of 1866 compelled those who could get away from town to do what they could for a living, and in that year we find that 30 tons of manganese were exported; their total value, however, was only £300, so that they were scarcely like "quartz specimens." But even this would be an estimated value to try the market, and it is generally understood that the amount realised was less than one-third of that amount. This metal is found plentifully at Gladstone, and very convenient for working and shipment, but £3 per ton is not a price likely to induce capitalists to mine for manganese.

A few gold specimens were also sent away, but they are only valued at £48, and probably had the same origin as those sent away during the previous year. There was an increase of more than 50 per cent. on the item copper during this year above the previous or any previous year, but with that exception there was no special evidence of mining activity, and it was not until the last quarter of the following year that the discovery of gold at Gympie gave to the mining industry that eminence and importance to the colony which at once proclaimed it as its saviour from the terrible destitution resulting from the collapse of the previous year, and so established the colony in the path of prosperity that in a few years the bitter experinces of 1866 were well-nigh forgotten.

Another small shipment of manganese was made during 1867, this time valued at £5 per ton, and sixty-four bags of minerals (unnamed) were sent away, but these were only valued at £40, and could not therefore have been gold specimens, nor any other very valuable metal, probably manganese, galena, plumbago, or copper, as several reports of discoveries were made about this time, and in the following year one ton of galena, value £10, was exported, as were also more manganese and more quartz specimens, and in 1869 three-fourths of a ton of plumbago, value £10, was exported, and another small shipment of manganese. This brings us to the close of a second period of five years, during which time we have produced minerals to the value of £1,927,217, or six times the production of the previous similar period; but a large proportion of this difference arose from the two full years of active production of the precious metal at Gympie. Indeed, the only other metal then produced was copper, and whilst it kept up its ordinary output there did not appear to be much increase; the last year of each period showing £60,000 and £76,230 respectively.

The discovery of gold at Gympie has had a far-reaching effect on the fortunes of the colony. Up to that time the total production had not reached 100,000 oz., and the condition of the colony was as low as it well could be; but that event not only drew hundreds of the unemployed from the capital, but gave an impetus to prospecting all over the colony; and in the following year the production reached 165,801 oz., and although it was slightly lower during the two following years it soon recovered, and, roughly speaking, has for many years past been nearly four times that amount. It is worthy of note that in the year 1851—the year of the discovery of gold in Victoria—Gympie appears to have had a narrow escape from being precipitated into a goldfield, for, according to the *Moreton Bay Courier* of 3rd November of that year, they had "learnt from Mr. Surplice, who left Wide Bay about nine days ago, and who arrived in Brisbane on Saturday night, that the reports of gold being found in the Wide Bay district are well founded. The gold exists at a spot about sixty miles this side of Maryborough, and several persons from the township had gone there to dig. Mr. Surplice informs us that he himself, when in company with Mr. Murray, picked up a piece of quartz containing a speck of gold, about the eighth size of a pea, in a creek about twelve miles from Mr. Murray's station. We cannot, however, learn that any appreciable quantity has been found, the working having only just commenced." Nothing appears to have been the immediate result of that working; but doubtless it was borne in mind by the timber-getters and station hands of the district, who, it is generally understood, "put Nash on" to the locality previous to his notable discovery in 1867. And where cattle picked up a precarious livelihood on ridges not of the first quality for that purpose, we now find an industrious people and prosperous township of 12,000 inhabitants, having its own municipal council, sending two members to Parliament, and supporting not only its own industrial population, but forming a market for and a means of interchange with a large suburban accession of farmers and others whom the necessities or the inducements of a goldfield tended to draw to the neighbourhood. The town has for many years past been connected with the port of Maryborough by rail, and is now also so connected with Brisbane.

The commercial prostration of 1866 was such as is rarely experienced by any community, but among the handful of people then comprised within the limits of the Queensland territory it was felt with unparalleled severity. The resources of the Government and Legislature were taxed to the utmost to find relief from their own difficulties, to keep the unemployed in order, and to find outlets for their energy. Commercial and mercantile men were at their wits' end to make ends meet when the news reached Brisbane of that timely discovery, which, from its easily accessible position from the ports of Brisbane, Maryborough, Noosa, and Maroochy, was soon the home of thousands of people; and from that time forward, with the assistance of other discoveries of the same nature, the prospects of the colony brightened, its character and credit were retrieved, and it went on its way rejoicing. It may have been that the pressure of hard times had a stimulating effect on the energy and industry of the people, for in the following year gold was discovered in the Gilbert Ranges, quickly followed by discoveries on the Etheridge and in the Central districts.

During the five years, 1865-69 inclusive, the total yield of gold amounted to nearly a million and a-half sterling, being £1,465,146; that of copper, £383,762; coal, £67,666; and other minerals, £10,643—making, as I have said, a total of £1,927,217; the production of the precious metal having been nearly twelve times that of the previous five years, whilst the gross mineral production had been multiplied by six during the same period. Gold had been discovered at Ravenswood in 1868, but its production was not felt until 1870, when a small mill of five stampers was erected. Discoveries were also made in the Central districts about this time, and attention was directed to the inferior metals, as small shipments of manganese, galena, plumbago, black sand, antimony, and one ton of silver ore were reported during the next five years, as were also the production of quicksilver and the shipment of quartz specimens, implying further discoveries of the precious metal, of which there were several of importance. The Ravenswood field already mentioned became a centre, and not only attracted a large population, but was the means of enabling prospectors to examine the surrounding country; and so the Fanning, Rochford, Kirk, Dreghorn, Mount Wyatt, Hillsborough, and other places were pospected and gold discovered; but by far the most important was the discovery of gold at the Towers, subsequently called Charters Towers—now, and for many years past, the premier goldfield of the colony, although it was for a time overshadowed by the mountain of gold in the Central districts; it has, however, produced more gold than that famous mountain, and more than any goldfield in the colony.

From 1870 the yield increased regularly; and with Charters Towers dating from 1872 and the Palmer from 1873, the prospects of the colony were not only brighter than they had ever been, but gave reason to hope for additional discoveries, owing to the greater extent of metalliferous country which had then come under the operation of the prospector and alluvial miner, for the Palmer was essentially an alluvial field, and was far outside of any previously existing field, either of quartz or alluvial workings. Gold at the Gilbert had also been discovered and worked during these years, and the last of this quinquennium showed a production about double that of any previous year, although regular increases had taken place for some years past.

The discovery at Charters Towers does not appear to have attracted that attention which its importance has since been proved to have deserved. The discovery of tin at Stanthorpe, about the same time, appears to have received far more attention, being in a more easily accessible position from the more populous portion of the colony, for, although not by any means so valuable a discovery, the tin was in the streams and in the alluvium, and was consequently obtained by the application of much less labour and capital than was necessary on a new and distant reefing field, even though a hundredweight of the product was only worth an ounce of that obtained in the more distant field, which required a large amount of labour and capital to procure it. But these discoveries were scarcely beginning to be realised when even a seemingly more important announcement was made that alluvial gold of surpassing richness and in incalculable quantity had been discovered in the sands of the Palmer River, in the far North of Queensland. The difficulties of travel, the absence of the necessities of life, the impracticability or utter absence of roads, the inhospitable nature of the climate, the miasmata of the swamps, the certain danger from the natives, were all as though they had not been; and such have not yet been experienced that would deter the intrepid and adventurous digger from pursuing his quest of gold and penetrating to its probable location on the first hint of the proof of that probability. And the result was a rush that equalled or surpassed that to the memorable Canoona, but without the disappointing and disastrous results in the absence of gold which was experienced from that ill-advised and unprofitable stampede. When the locality was safely reached gold was plentiful, and, that desideratum accomplished, a host of difficulties, of which there were many, disappeared, and fortune appeared within the grasp of the successful travellers.

The discovery, made by an exploring party, was hundreds of miles beyond any considerable settlement. There was no convenient port then opened or well known to navigators which could be used for the ordinary requirements of passenger and goods traffic; the route from whatever port would be through unknown, unexplored, and hostile country; the locality was seven degrees north of the Tropic of Capricorn, where the tropical sun evaporates any moisture which the parched earth and the open sands of the rivers, the detritus of a granitic formation, have not already absorbed during the long dry seasons which prevail there. But the Endeavour River was utilised as a port, and the other difficulties were set at defiance, when, after a short experience, it was found that this discovery eclipsed everything of the kind previously made in Queensland; and, notwithstanding the almost inaccessible position, the locality was soon transformed from a sterile wilderness into a scene of busy industry and activity, and yielded during the first five years of its existence nearly 1,000,000 oz. of gold of very rich quality. This yield has not, however, been maintained. The Palmer has suffered the fate of all alluvial fields, without having reaped the advantage of a corresponding development of reef mining, although rich reefs have been discovered in the vicinity, for the climate is not such as to induce settlement unless with the prospect of speedy wealth and comfortable retirement; nor is the quality of the land such as to conduce to close agricultural settlement. It has, however, contributed in a marked degree to the pastoral settlement of the country, which has again reacted on the prospecting for minerals, from the facilities thereby afforded by the various homesteads, and their necessary means of communication with the coast towns.

The advantages of such a discovery as the Palmer Gold Field are not, however, so devoid of alloy as the gold obtained there, for the nomenclature of the neighbourhood smacks strongly of experiences other than those originating in the abundance of the mineral wealth with which the more fortunate were rewarded. Among such names are Battle Camp, Murdering Hut, Hell's Gates, Cannibal Creek, and Poverty Point; all which originated in and perpetuate the memory of some encounter, some treachery, some reprisal, some hope abandoned, expectation vanished, or unanticipated grave tenanted.

But such are some of the risks encountered, the experiences endured, or the contests sustained, and conquests achieved in the gratification of that thirst for gold, which impels the nomadic digger to rush to the uttermost parts of the earth in quest of the precious metal.

During the five years now under review the total mineral production of the colony was more than three times that of the preceding five years, and more than eighteen times that of the first similar term of the existence of the colony.

The item "Gold" had given a value of £3,840,053; copper had more than doubled in its production, and coal increased but slightly, the former giving a value of £800,943, and the latter £79,590; whilst tin had been obtained in about half the period to the value of £1,074,550, and other minerals £27,483, making a total for the five years of £5,822,619—an enormous accession of wealth for a population numbering from 100,000 to 150,000 during the period included—an accession which lifted the colony from the depression and despondency into which it had fallen in 1866, and placed it in a substantial and prosperous position, with the prospect of many years of uninterrupted success in the industry which had done so much to galvanise its dormant existence into vigorous life and activity.

The production of gold during the next five years appears to have almost monopolised the attention of the mining population of the colony, for during the period 1875 to 1879 it contributed four-fifths of the total value of the production of the mining industry, although during the latter years of the period a considerable falling off was noticed, as was to be expected, from the alluvial yield at the Palmer; the only new field of importance which had been discovered during this interval being the Hodgkinson, which sprang into existence in 1876, and, although passably rich at first, was far from compensating for the falling off from the alluvial yield of its northern neighbour; neither has this field retained the prestige which it received and appeared to deserve in its earlier years.

The alluvial tinfield at Stanthorpe shared the fate of alluvial goldfields, and after the first few years suffered a considerable shrinkage in its production of tin. So that from the year 1874 there was a considerable falling off in our mineral output, and the same total result was not again obtained until 1887. The yield of gold showed an increase in 1875, but not sufficient to counteract the falling off in the production of tin, and from that time forward gold and tin fell off, although the production of the latter was supported by new discoveries at Granite Creek, in the Palmer Gold Field, and later on the Walsh, Tate, and other rivers in the Northern portion of the colony.

The total result of operations during this fourth quinquennium of the colony was of the value of £7,626,576, of which the goldfields contributed £6,166,509, being an increase of 60 per cent. over the previous similar period. Copper yielded £506,234, being less than two-thirds of the previous production, this loss resulting almost wholly during the last two years of the period, when one of those unaccountable depressions in the price of copper took place which are felt most severely in this the most distant producing field from the great markets of the world. Tin had receded 29 per cent., and represented a cash value of £767,269. Coal yielded £110,995, or an increase of 40 per cent.; and other minerals £75,569, a very large increase over the production of the previous period. The increase in the last-mentioned item was greatly due to the opening of the Ipswich to Brisbane railway, facilitating the quarrying of stone and carriage to Brisbane both for road metal and higher engineering and architectural purposes.

Stream tin had been discovered at Tinaroo and on the Barron River towards the close of this quinquennial period. But the lode tin of Herberton does not appear to have been discovered for some little time afterwards. From the commencement of the period '80 to '84, however, tin from the alluvium and the streams was worked in the Wild, Dry, Tate, Walsh, and Star rivers; and in July, 1880, application was made for a piece of land on the Wild River for working lode tin, and this is within, and was the origin of, the township of Herberton. It appears to be with the stream tin as with alluvial gold—Nature provides this species of liberality to give sustenance and encouragement to the miner as a set-off to the difficulties of pioneering; it is easily procured but soon exhausted, yet, if properly economised and utilised, leads the way to the more enduring form of reef or lode mining, and this has been accomplished at Herberton, the principal centre of mining for the useful as distinguished from the precious metals now in the colony, for the promises of permanency held out by such a discovery have every appearance of being amply fulfilled both as to lodes of tin and other valuable minerals.

It is interesting to note the indifference with which the useful metals are spoken of in reports from the North, as—"Copper, antimony, lead, and tin all exist in a large area of these fields, but for a long time to come they will be regarded as depreciating rather than improving the importance of the district." These minerals have, however, contributed to the importance of those fields, and form an important item in their assets.

The Cloncurry has yielded copper, the Hodgkinson antimony, Ravenswood lead and silver, and the numerous rivers already mentioned, comprising the Tinaroo district, tin; but gold only has up to the present been the fitting reward of the industry and capital of the miner and mining investor in the Etheridge district, the largest of our goldfields and the furthest removed from communication by rail or sea with the centres of commerce and civilisation.

During the succeeding quinquennial period, 1880-84, when the abnormal increase brought about by the alluvial yield of the Palmer had abated, and nothing new had been discovered to sustain it, a very considerable falling off was observed, for in 1883 the yield had fallen lower than it had ever been since 1873. Of the ten years the last was the poorest; but when things come to the worst they begin to improve, and before this complete declension had been consummated the silver lining—if the inferior may be used to symbolise the superior metal—shone through the cloud. Mount Morgan had been found to contain gold; and although some time necessarily elapsed before machinery could be erected and the mine developed, it was proved at a very early period that large quantities of gold would be produced. It is a difficult matter to predicate the quantity to be obtained from a reef where only a point has been laid bare, probably by trenching, and it is found to be ill-defined. It is difficult to estimate the production of alluvial gold, as that of a few loads of earth or sand gives no guarantee of its continuance in like proportion, but here were the huge boulders, fragments of the mass of the mountain, scattered over its slopes which could be tested at all points, the mass itself being but slightly covered with the abrasion and oxidation of time and the atmosphere, so that no difficulty was experienced in obtaining ample evidence of the enormous wealth which lay dormant in the bare, craggy, uninviting slope projecting into the 640-acre selection, lately the property of Mr. Gordon, but which had been transferred to the Morgans for a consideration of sufficient value, perhaps, when estimated as a very poor grazing selection, but insignificant when compared with the wealth of the precious metal and its position as the key to the top of the spur which contained perhaps the principal portion of the auriferous deposit, and which was secured at the outset by the wide-awake proprietary, making the largest, richest, and most complete gold-mining property in Queensland or the Australian colonies, and which was not long in adding its quota to the output of the colony.

That the proprietary had its difficulties from the want of water and the finely diffused condition of the gold in the stone is unquestionable, but money answereth all things, and these difficulties were soon overcome, and from that time the position, prospects, and doings at "the mountain" have been familiar to the public. The formation of the proprietary into a public company; the various "jumping" companies formed; the trials in the colony, and before the judicial committee of Her Majesty's Privy Council; the upward tendency of the scrip, its rise to a nominal value of £16,000,000 sterling, the bets and anticipation that it would shortly and justifiably rise to £20,000,000; the gambling speculation to which it almost of necessity gave rise, and the consequent collapse of some of the speculators, are all matters of current history. But the great fact remains that the mountain gives employment to about 1,000 men, in addition to those who swarm around it on all sides in the hope of picking up some portion of its outstretched arms, or of being wet with the spray by which the mountain was impregnated.

The yield of gold for the quinquennial period 1880 to 1884 was valued at £4,397,378, showing the serious reduction of 28·7 per cent. from that of the previous similar period. Coal yielded £200,117, or an increase of 80 per cent. Copper fell to £106,708, being little more than one-fifth of the former yield. Tin, £924,332, or an increase of 20 per cent. Silver and lead ores, which had previously been barely touched, now yielded £146,931; and other minerals, £90,929; giving a total of £5,866,395, or a decrease of 23 per cent.

The only addition to the list of minerals produced during this period was opals, for which the sum of £1,900 is credited in 1882; but although various kinds of precious stones have been discovered from time to time, it does not appear that the search for them has ever been systematically prosecuted. The production of silver had been previously commenced, as samples had been obtained and exported, but during this quinquennium it became a production of importance. This ore appears variously as galena, lead, and silver, and as silver ore; probably it was galena in all cases, which is not valuable here for its essential metal and metalloid, lead and sulphur, but generally contains the accidental mineral silver, and is payable or otherwise according to the quantity contained in the ore.

In connection with the production of gold a difficulty was met with in the North which had not been seriously experienced further south. It was found that a large quantity of gold was being lost owing to the difficulty of manipulating the complex ores which abound at Ravenswood and other places. But science and the mechanic arts have done much to remedy this defect, and the science and genius of the initiated are still being brought to bear on the difficulty, as there is ample room for improvement both in the art and science of treating such ores, which are common both in the Central and Northern districts.

With the declension of the alluvial yield at the Palmer and the undeveloped condition of Mount Morgan at the close of the fifth quinquennial period, our yield had suffered a serious reduction, but at this time the tide turned. The year 1885 gave an increase over the yield of 1884, and a further increase occurred during every year of this sixth quinquennial period, until the output culminated in the last year (1889) in the highest we have yet had, and in placing Queensland at the head of the Australian colonies as a gold producer, the quantity obtained during that year being 739,103 oz., of the value of £2,586,860, and the total during the five years ending with 1889, 2,298,608 oz., of the value of £8,045,126 sterling, or an increase of 83 per cent. over the production of the previous similar period. Coal was valued at £528,996, or an increase of more than 160 per cent.; copper at £54,768, or a trifle over half that of the former period; tin, £887,809, showing a decrease of 4 per cent.; silver, £302,115, or an increase of 105 per cent.; and other minerals, £141,183, being an increase of 55 per cent.; making a total of £9,959,997, and an increase of nearly 70 per cent. on the former period; the production of bismuth being the most important addition to the list during that period.

At the close of this period Mount Morgan was in its zenith, and produced during the last year within a minute fraction of 10 tons of gold, since which it has fallen off considerably, but is still able to make important additions to our annual output, and will, it is believed, continue to do so for many years to come. Gympie also gave its greatest yield during that year, and has fallen off somewhat during recent years, the floods of 1890 and 1893 having been very disastrous to that field. There is every reason to believe that better times are in prospect for it, however, as steps have been taken to prevent a recurrence of such results, and the mines have recently largely increased the yield, so that the last year is less only than two of its predecessors. The seventh quinquennium has now elapsed, and although we are not in a position to give all the details of production for the last year, we have the principal item, "Gold," and are therefore in a position to give a tolerable estimate of the general result. It is quite certain that both as to the gross mineral production, and as to the production of the precious metal, the past five years have seen important advances. During no similar period has the output of gold at all approached that of the period just passed, the result being the production of 3,093,854 oz., or more than 94·7 tons of gold, which, at the value of £3 10s. per oz., gives £10,828,489; but that average value was fixed in early days, and the rich alluvial of the Palmer, the chlorinated gold of Mount Morgan, and even the reef gold of Charters Towers have all been of a much higher value, and have constituted the bulk of the gold obtained in the colony. The five years each gave a fair average yield, but the last was the highest, and exceeded all previous years except 1889, when the phenomenal yield of 10 tons was made by Mount Morgan; but all the other principal fields have well maintained their position, Charters Towers especially, with a result of 1,173,177 oz., or nearly 36 tons of gold, during that period; and several new discoveries have also materially contributed to the gross result, which, although at present of comparatively small importance, may yet develop into goldfields of no little value to the colony, the total yield of which has now exceeded 303 tons of gold.

The production of coal has also increased largely during the period in question. The first year, 1890, gave the largest yield we have yet had; this, however, was brought about by exceptional circumstances, and not by any permanent development of trade. The succeeding years fell to the normal condition, but during the four years which have passed the yield has been higher than that for the preceding five years, and we may therefore expect an increase of about 25 per cent. on that item during the quinquennium—an increase fairly commensurate with the general increase of the colony, to the trade of which we are confined. The state of the markets for copper has been such as to cause complete stagnation in the industry of mining for that metallic ore. The production for the four years of which we have the returns has been a little over £10,000, and the past year will not have added materially to the gross result. But even of this a considerable proportion is obtained as a by-product from the argentiferous ores, and in this way assists in making those ores payable, although the price of silver has also suffered serious relapse during recent years.

The items silver, silver ore, silver lead bullion, lead ore, and galena appear, but may be taken collectively, as the silver is the object, or the principal object, of mining for these ores; and, as above hinted, has suffered in price, and that to such an extent as seriously to interfere with the regularity of mining operations in that behalf. The value of the production for the four years is given as £157,362, but curiously enough the Customs return for the year 1893 shows a far higher value exported than the production of all the four years. Can it be that our silver-miners are in such a good financial condition that they accumulate stocks for several years before realising; or in what way can we export so much more valuable material than we raise from the mines?

The production of tin during the past few years has not quite kept pace with previous years. The value for the first four years of the seventh quinquennium somewhat exceeds half-a-million sterling, and therefore indicates a decrease of about 25 per cent. on that of the previous period. The decline is in part due to the declension in the price of that commodity, but is also to some extent due to diminished production, for a decline in the price operates both in showing a less value for the same quantity, and by discouraging production where that operation would be unprofitable.

I have endeavoured to put before you some of the results of geological science applied with art to the production of the metals and minerals useful to civilised humanity. I am aware that I have departed somewhat from the primary objects of our association, "The Advancement of Science"; but "the mere extension of our knowledge is of comparatively little importance, however sublime the truths developed, or however hidden the secrets disclosed, unless they promote the comfort, or convenience, or happiness of mankind," and the science of Geology is recommended, not only by the sublimity of of the facts which it brings under our observation, but it is of the greatest utility to mankind in a civilised state, as it affords the means of more readily procuring the substances to which I have referred—as well as the indispensable substance, the subject of the very excellent paper brought before us by Mr. Jack yesterday morning: substances to the production of which the science of Geology has been of essential service in this colony, and without which civilised society in its present state could not possibly exist.

11.—NOTES ON TIN-MINING IN AND AROUND HERBERTON, NORTH QUEENSLAND.

By JOHN MUNDAY, Mining Engineer.

Tin is found in the Herberton district both in massive and stratified rocks. It was first discovered in the granite hills of Tinaroo, about midway between the coast and Herberton, in the year 1878; and in 1880 the prospectors extended their operations to Herberton. The Kangaroo Hills tin country lies 120 miles to the south, and to the north are the tin-bearing ranges stretching towards Cooktown.

From Herberton as a centre, lode-mining has been extended westward to Watsonville, Irvinebank, Eureka Creek, and Koorboora, and south-westward to Coolgarra, Glenlinedale, and California Creek;

covering a radius of nearly 40 miles. Alluvial mining has been carried on in the same direction from Herberton to the Tate River and Fossilbrook, a distance of over 80 miles. Within the same limits are developed other minerals of economic value, including lead, silver, copper, antimony, and wolfram. The gold-mines of the Hodgkinson, Mareeba, and the Russell lie to the north and east.

LODE-MINING.

The following observations apply more especially to the neighbourhood of Herberton:—

In this locality the preponderance of the outcropping tin-bearing rock is porphyry. Where seen in the deep ground this rock assumes a granitoid structure, and hornblende at times is present as a constituent. The decomposition of the felspar is characteristic, and streaks of carbonate of lime may be observed in some of the rock joints. White mica is not much present, there being a difference in that respect from the granite country to the west. Tourmaline is likewise rare, contrasting thus with the stanniferous rock at Cooktown.

There are outcropping patches of granite, but their extent is limited.

The country is subject to what miners term "slides," normal and reversed faults, both being encountered in the mines. It is also traversed by dykes of elvanite of varying thickness, intersecting the lodes at different angles. In two instances, at Herberton and Watsonville, where I have seen such dykes driven through at 300 feet from the surface, a clay seam was followed conforming to the strike of the lode, and the lode fissure reached on the other side; but the lode was not shifted, nor was its course changed. In these instances the dykes were not in themselves stanniferous, but tin was present in the lodes at a short distance from them.

Mr. R. L. Jack, in his geological report, describes the tin-producing veins of this district as metamorphosed igneous dykes, having probably a diorite origin, and at present consisting mainly of quartzose chlorite and quartzose serpentine. In deep ground I have observed that these veins develop more quartz, and present a greater resemblance to ordinary lode veins, the enclosed mineral being in a more banded form and parallel with the walls of the enclosing fissure. For convenience of description they will be referred to as lodes in the following remarks.

The strike of these dyke lodes is more or less meridional, but they have no uniformity in that respect, varying in all directions; nor have they in the direction of their dip, which is sometimes to the right and sometimes to the left, generally at a steep angle. In length they have been traced at surface and underground several hundred feet. In width they vary from 1 or 2 to 25 feet wide, and suddenly expand and contract.

The deposits of tin do not always take place in the chloritic mineral filling up the main fissure, but are sometimes found connected therewith as branch veins, and in such cases the matrix of the ore consists mainly of quartz, the chlorite element being less prominent.

When the ore occurs in the lodes with the chlorite the stone is usually very good. The country rock adjacent to the lodes usually shows some evidence of change, its felspar element giving place to dark-coloured hornblendic mineral. Joints in the veins and from the contiguous rock generally favour the deposition of tin.

The ore occurs as cassiterite, and mostly in lenticular deposits, varying in size from small pipes up to bodies the whole breadth of the lode, and reaching in length to 40 and 50 feet and in depth from a few down to several hundred feet. Their yield ranges from 5 per cent. to 40 per cent. and over of oxide. Patches of iron pyrites appearing in the lodes are considered a good indication. Wolfram, fluor-spar, galena, and molybdenite also occasionally accompany the tin.

Apart from such concentrated bodies, the mass of the mineral constituting these chloritic lodes is, for the most part, poor in tin, probably not yielding over 1 per cent. of that ore.

The Great Northern Mine at Herberton has been opened in two lodes of the kind just described, and has produced over 4,000 tons of dressed ore. In one of these lodes the ore-shoot lasted down to a depth of 570 feet, leaving ore in thin seams still in the bottom. The shoot was found most productive between 100 feet and 300 feet from grass.

Numerous deposits of ore have been found in veins in the hills around Herberton; but, except those in which chlorite appears as an element, they have usually not been very productive.

Proceeding westward from Herberton toward Watsonville, over porphyry ridges, at a distance of about five miles the Main Dividing Range is crossed at an elevation of 3,650 feet above sea-level. On the western slope of this range the traveller passes over an outcrop of stratified rock consisting of greywacke and shales. The North Australian Mine is opened in this formation. In some of the shallow workings of this mine the tin is associated with rich carbonates of copper, and with iron and arsenical pyrites. The deposits are irregular, and occur between bedding planes of the enclosing rock. There are faults in the locality, indicating a course by which the tin probably arrived at the surface. The North Australian shaft is 200 feet deep. At the bottom a level has been driven through mineralised ground, toward the north; but the deep country has not yet developed any important tin deposit. At the commencement of this mine the prospectors discovered a deposit of mineral close to the surface which yielded over 400 tons of marketable ore.

The principal other Watsonville mines are located on the summit and on the northern flank of a portion of the Main Dividing Range known as the Western Hill, extending two miles onward as far as the township of Watsonville. The crown and to a large extent the northern slope of the Western Hill consist of porphyry, and the tin-bearing veins present much the same features as those at Herberton, but the ore is more impregnated with copper and arsenical pyrites. The ground is intersected by similar dykes of elvanite. Outcrops of some of the lodes yield small quantities of silver. The deepest mine is the T Claim, in which the ore-shoot has reached a depth of 330 feet from the surface. Several rich deposits of ore have been worked on the Western Hill Range, extending to a depth of 200 feet; but as yet exploration has not gone much beyond that limit, except in the instance just mentioned. Granite comes in about half-way down the face of the hill, northward, in the direction of the township of Watsonville, which is situated at the foot of the range. Some of the mines are opened in the porphyry within a short distance of the granite, but I am not aware of any working in the granite itself.

At Irvinebank, 10 miles west from Watsonville, there is more lode-mining. The tin lodes occur here in sedimentary rock, which is understood to correspond with the greywackes and shales of the Montalbion silver country, 4 miles further on.* The composition of the lodes is mainly chlorite, arsenical and iron pyrites, and spathose iron being accessories

The Great Southern and Vulcan Mines in this neighbourhood have produced considerable quantities of ore, as have also several other mines of less importance. In the two referred to, the ore deposits have taken the form of large shoots. The Great Southern shoot extended almost vertically from the surface of the ground down to 150 feet, in a massive state, covering a horizontal sectional area of from 600 to 1,000 feet. At that depth it diminished in bulk and dipped at a low angle toward the west.

The Vulcan Mine has been productive from the outcrop of the lode down to 300 feet, the ore-shoot sometimes extending over an area as large as that of the Great Southern. A fresh body of ore has recently been struck here in the deepest ground. In this mine bismuth in small quantities is associated with the tin. The Great Southern Mine has yielded 1,321 tons, and the Vulcan over 1,900 tons of dressed tin.

Glenlinedale, about 10 miles to the south of Irvinebank, furnishes an instance where a large outcrop of tin-bearing stone was found at the junction of the lode with a strong elvan dyke. The country rock is schistose, sandstone, and shale. Granite becomes exposed about ½ mile from the mine, towards the south. The principal constituent of the lode is a hard, dark-coloured, brittle quartz. The heavy surface outcrop, which covered a sectional area of 1,000 feet, was followed down to about 150 feet in depth, when it broke up in a mass of vertical layers of sandstone. The yield of ore from the stone taken from this mine was 6 per cent.

At California Creek, 28 miles beyond Irvinebank, to the south-west, cassiterite presents itself in lodes in the granite; but the ground is hard and the veins narrow. In the same neighbourhood tin occurs in lodes in a bed of sedimentary rock lying between granite hills. Where the lodes crop out in the granite the ore is associated with quartz. In the stratified rock it occurs chiefly with chlorite, as at Irvinebank.

At Coolgarra, lodes have been wrought in the greywacke and shale, but granite appears over a large portion of the outlying country.

At Koorboora the lodes occur in stratified rock, and at Eureka Creek in both stratified rock and granite.

* This formation, from Mr. Jack's recent investigations, presents indications of a Devonian character.

In the Tate district the country rock is granite. At Mount Borunda, in that locality, the ore is developed in floors of decomposing granite, which stretch along the outcrop of the lode. In this case muscovite forms a prominent feature in the stanniferous matrix, and the ore is very free from foul mineral. None of the mines are much troubled with water. Shafts sunk in the sedimentary rocks encounter most water, those opened in the porphyry being comparatively dry.

ALLUVIAL MINING.

When tin ore was discovered in the detritus from the lodes, the search for alluvial ore naturally took an active form, and it has so continued ever since. Most of this class of ore is derived from open gullies. It is also obtained from drift now covered by rock of volcanic origin. Titanic iron at times accompanies the tin, but this takes place more particularly in some of the western country, and where the tin-bearing drift lies under decomposing basalt. Gem-stones are likewise found.

South of the town of Herberton a large area of tin-bearing drift occurs under a sheet of basalt, having no doubt been brought there from the adjacent hills. It is chiefly worked by tunnelling from the Wild River Flats, the tunnels serving for drainage and transit-ways from the mines to the surface. Shafts sunk through the basalt to the alluvium go to a depth of 60 feet. In some places a sandy drift settles down between the stanniferous gravel and the volcanic rock, and in others the basalt lies close down on the wash itself. The ground mined over extends to a length of 3 miles, the most important portion of which, at Nigger Creek, seems to have formed the site of a small lake resulting from the meeting of streams from the surrounding country. The gravel varies in thickness from a few inches to 3 or 4 feet. The average yield of the gravel is about 50 lb. of tin ore to the ton, or $2\frac{1}{4}$ per cent. The grain of the tin is generally well rounded, and the colour grey. Grains of gold are found in this alluvium, but in no appreciable quantity.

Alluvial tin is worked in the gullies and creeks of the granite country between Herberton and Coolgarra, and in the vicinity of that township. Veins showing tin crop out in the granite, but no mines of any importance have yet been opened in them. The Innot mineralised hot springs are situated in Nettle's Creek, one of the tin-producing streams of the district.

The California Creek granite country, and the Tate River and Fossilbrook granite and porphyry ranges beyond, are sources of stream tin. The Tate district has produced ore of this class during the last thirteen years.

PRODUCT OF TIN ORE.

The quantity of marketable tin ore produced in the whole district from the discovery of the field in 1878 to the end of 1893, as obtained from official documents, is 24,845 tons. Of this 4,704 tons may be estimated as stream tin, and 20,141 tons as the result of lode-mining. The districts of Herberton, Watsonville, and Irvinebank have produced nearly equal quantities of lode tin, the preponderance being at the first two mentioned. The stone crushed has been about 140,000 tons, yielding a product of 14·4 per cent. of "black tin." The tin ore obtained has been worth, on the average, about £45 per ton on the ground.

After the stone is taken from the mines, owing to the low yield of the general mass of the vein stuff, and the comparatively heavy charges for carting to the mills and crushing, it is usually subjected to a process of hand-dressing before sending it to the mills, and hence the high average yield of ore from the stone crushed.

The yield of metal from the ore produced by the following rock and alluvial formations in the district may be approximately stated as follows, the lode ore not having been put through any process of calcination :—Herberton porphyry : Crushed lode ore, 69 per cent. Irvinebank sedimentary rock : Crushed lode ore, 62 per cent. Herberton porphyry : Deep lead alluvial tin, 73 per cent. Herberton porphyry, ranges : Alluvial tin lode detritus, 71 per cent. Tate and Coolgarra, granite : Alluvial tin, 74 per cent.

Until about a year ago it was the custom to crush and prepare all the lode tin for the market without washing, the oxide being sufficiently clean to dress out therefrom a marketable product ; but at Irvinebank, where the sedimentary rock prevails, calcination and lixiviation have recently been adopted, by which the volatile and soluble products are got rid of, and the ore raised up to a value of 70 per cent. for metal.

Stream tin taken from the old deep drift beds is of a purer quality than that obtained from lodes in the same locality, whether it be in the form of detritus from the open gullies or crushed ore from the mine.

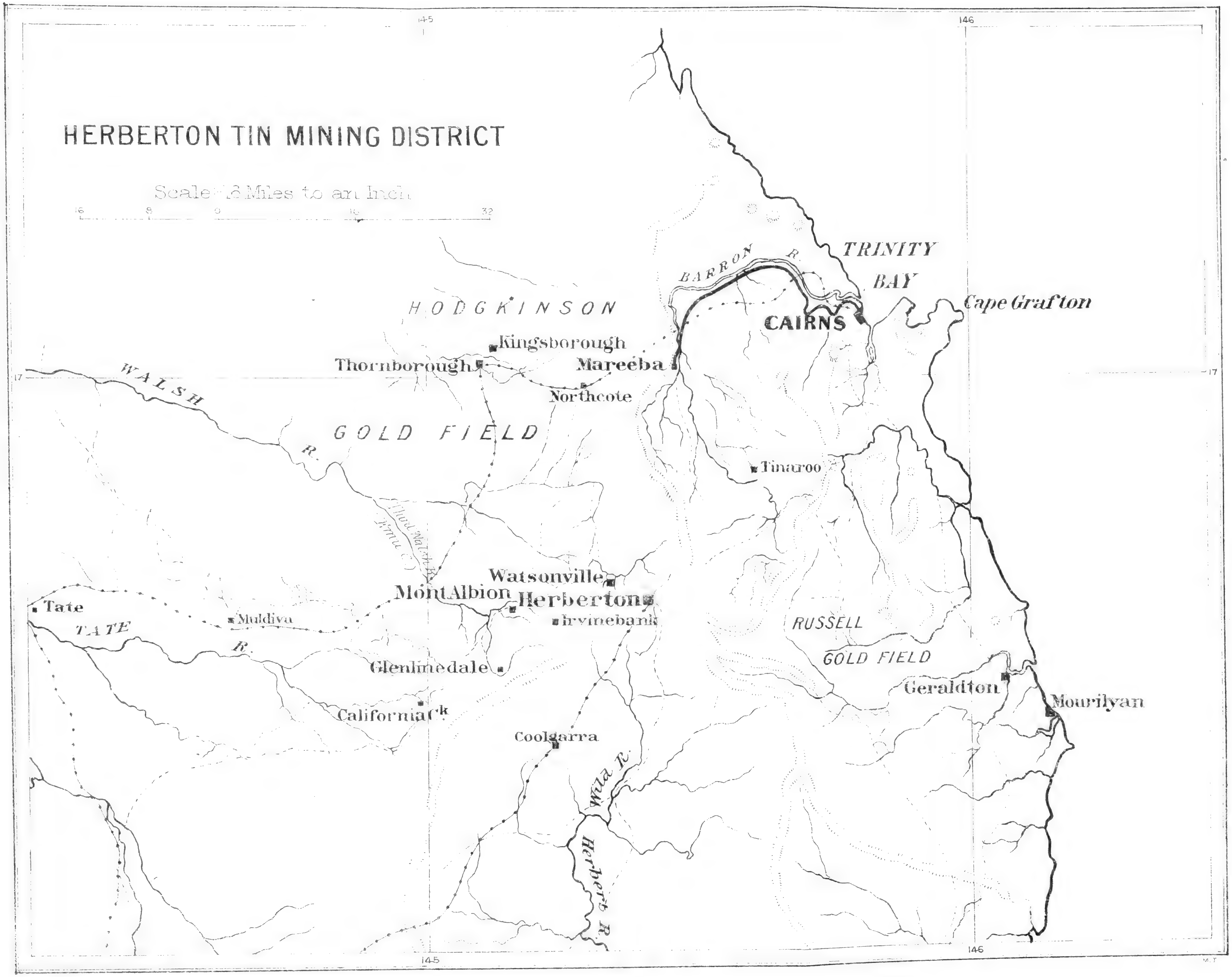
It will be noticed from the list of assays just given that granite stream tin yields a larger percentage of metal than either porphyry or sedimentary rock ; also that ore mined from the porphyry produces a higher percentage than ore, in an unroasted state, taken from rocks of aqueous origin, being less impregnated with minerals which lower its value, such as copper, arsenical pyrites, and bismuth.

Stream tin from the granite has mostly a ruby tinge, and has been ascertained to be slightly impregnated with nickel, iron, and lime. The bluish-grey ore from the porphyry contains iron and lime, but no nickel. Mr. Henderson, Government Analyst, in a recent report on the subject, considers that the difference in the colour of the ore is not the result of chemical composition, but is more probably due to its deposition under different physical conditions.

DRESSING MACHINERY.

At present there are in operation and in course of erection in the district five stamping mills of from five to fifteen heads each. They are all driven by steam power, except the Bischoff Mill, which is worked by a turbine, operated by water from the Walsh River. The mills are all of the usual type.

The process of dressing the ore varies in the different mills, but in all cases the advantage of hydraulic classification, and the cleaning of the rougher portion of the sand by the process of jigging, is recognised. The treatment of the slimes is different in different mills. At


HERBERTON TIN MINING DISTRICT
Scale 16 Miles to an Inch
16
8
0
16
32
145
146
17
HODGKINSON
GOLD FIELD
WALSH R.
BARRON R.
TRINITY BAY
Cape Grafton
CAIRNS
Kingsborough
Thornborough
Mareeba
Northcote
Tinaroo
Watsonville
Mont Albion
Herberton
Irvinebank
Tate
TATE R.
Muldiva
Glenlinedale
California Ck
Coolgarra
Wild R.
Herbert R.
RUSSELL
GOLD FIELD
Geraldton
Mourilyan

Herberton convex and concave buddles are used. At the Bischoff Mill, Watsonville, revolving tables are in favour; and, at Irvinebank, Frew vanners and stationary round tables. "Dollying"—the process by which the last heavy slimes are eliminated, by mixing the ore in tubs, and subsequent percussion—is the last stage in the work of dressing. The dressed ore is then dried, and put into bags of about 1 cwt. each, and sent to market.

At Irvinebank, the Irvinebank Tin Company have established a smelting furnace, at which most of the ore raised in that locality is smelted. The larger proportion of the product of the district has hitherto been exported to Sydney and smelted there, only a very limited quantity having been sent to England.

In the year 1893 there were 783 men employed in lode and alluvial tin mining in the district.

12.—ANTICLINES AND SYNCLINES, AND THEIR RELATION TO MINING.

By ERNEST LIDGEY.

13.—THE ANTIQUITY OF MAN IN VICTORIA.

By W. H. FERGUSON, A.R.S.M. Vic.

14.—NOTES ON THE TIN DEPOSITS OF THE BLUE TIER, ON THE NORTH-EAST COAST OF TASMANIA.

By HENRY GRANT, Barrister-at-Law.

15.—NOTES ON SOME FOSSIL CEPHALOPODA FROM THE SILURIAN ROCKS IN THE NEIGHBOURHOOD OF BATHURST, NEW SOUTH WALES.

By W. J. CLUNIES ROSS, B.Sc., F.G.S.

Section D.

BIOLOGY.

1.—PESTIFEROUS FUNGI, AND THEIR MODES OF ATTACK.

By Dr. M. C. COOKE, M.A.

Investigation of the vegetable features of any new country naturally commences with the study and determination of the most prominent objects, such as the trees, shrubs, and the most common or conspicuous of herbaceous plants; and it is not until these have been comparatively exhausted that the more humble and inconspicuous cryptogamia receive any systematic attention. These obscure organisms are, nevertheless, capable of revenging themselves for such neglect, sooner or later, by compelling cultivators of useful or ornamental phanerogams to recognise their power of inflicting injury, and compelling such cultivators to inquire into the character, mode of life, and reproduction of those parasites which they had been disposed to pass over in silence and contempt. Of all the lower cryptogamia the fungi are pre-eminent for their destructive tendencies, and until recent times they were the least known and understood. It is now recognised that wherever plants are cultivated on a large scale, for pleasure or profit, such culture will have to be conducted in the face of a strong opposition from parasitic fungi, increasing in number and in power with the progress of cultivation. Consequently the study and investigation of fungi is no longer a dilettante amusement, but becomes a stern necessity.

There are three principal directions in which the study of fungi may be pursued. Firstly, the larger fleshy fungi only may occupy the attention, and these with the object of ascertaining their merits or demerits as articles of food, the possibilities of submitting them to cultivation, or of ascertaining the conditions under which they are produced. This is the purely gastronomic interest, and its end is the production of pretty pictures and the elaboration of savoury dishes. Secondly, the investigation may be an absolutely scientific one, upon purely scientific lines, and merely for systematic purposes. Its great objects are the minute distinctions between one species and another, their affinities and their differences, the elaboration of schemes of classification, and the indefinite multiplication of names and sections. This is chiefly a mechanical interest, and its aim the production, upon paper, of the most formidable array of Latin names in some novel sequence or combination. Verily! they have their reward. Thirdly, there is the biological method, in which the external form and development is but one aspect, whilst names and affinities are but helpers, and not the objects of investigation. In this process the whole of the life-history of the parasite has to be ascertained as far as possible, all its means of reproduction, and whatever promotes or hinders its career or affects its existence. This latter is evidently the only successful mode to be adopted if the parasite is to be brought under control, and the host-plant saved from its depredations. For the pursuit of this method it will be evident that local investigation is indispensable, and that all the surroundings must be taken into account. The mere determination of a scientific name may be made from a mature fertile specimen, without regard to its development; so that there is no hindrance to the production of a long and elaborate list of names, but such a course leaves the great mystery unsolved—How is the disease to be met, prevented, or eradicated? This can only be solved effectually by a knowledge of the life-history of the offending parasite, and this can only be fully obtained at the place of infection. Thus much it is necessary to premise in order to show that, in countries where the crops have become subject to the attacks of fungus pests, local investigation is indispensable, except in such cases as are universal as to parasite and host, as well as in manner of attack, and then analogies will prove suggestive.

We are well aware that enormous losses in fruit and grain crops may be caused by parasitic fungi if they are permitted to establish themselves, either on account of indifference or ignorance. We are also aware that these losses may be largely diminished by active measures, if taken in time and pursued perseveringly. Wherever orchards or vineyards have suffered, whether in Italy, France, or the United States, successful experiments have followed, which have resulted, if not in the conquest, certainly in mitigation of the disease. It has also been demonstrated that the particular mode of treatment which has succeeded in one locality has not been equally successful in another, which indicates that local surroundings and climatic conditions must be taken into account; and that, although one treatment may not succeed, it is possible that another may produce excellent results.

The inference is that not only should the life-history of these parasites be clearly ascertained, but also those minor modifications which may result from any peculiar mode of culture, from difference of soil or climatic conditions; and also that a knowledge should be acquired of the various remedies which have been tried from time to time in other countries, with the view of testing their efficacy and recording the results. However much the energy of private individuals may accomplish, the knowledge of results is, to a great extent, confined to themselves, and the general interests of the community are not improved by the expenditure of much capital and labour. In countries where well-organised departments of agriculture, experimental stations, or other official centres are established, all experiments with their results are fully recorded, and the records are freely distributed for the benefit of the public. As it is a national loss that so many thousands of pounds annually should fall a prey to fungus pests, it would be a national advantage to establish organisations for the purpose of encouraging experiment, of collecting and distributing information, and generally aiding in the mitigation or extirpation of insect or fungoid pests which affect national industry.

It cannot be urged too often the pressing need of distributing and disseminating information as to the life-history of the various plant parasites, and, as far as known, of remedies which have been more or less successful. One of the most rudimentary lessons to be inculcated is the demonstration that parasitic fungi may be arranged under two types, each with a different mode of development, and each requiring a different mode of treatment. It is, at the least, essential to know to which of these types any given pest belongs before effectual steps can be taken against it. We have called these two groups the *epiphytal* and the *endophytal*. The former includes those fungi which establish themselves on the surface of the leaves, stems, or other green parts of living plants, and ultimately cause destruction by a kind of suffocation, and not by affecting, distorting, or absorbing the internal tissues. It is natural to suppose that it is this type of fungus pest which is most amenable to the application of fungicides, the object being to destroy the parasite without injury to the host-plant. We may give as examples the hop mildew and the *oidium* of the vine, either of which are to be kept in check by the application of sulphur. In these cases a white mould is developed in irregular blotches or broad effused patches over either or both surfaces of the leaves; the inferior stratum consists of delicate interwoven threads, forming a mycelium, which attaches itself by means of *haustoria*, or suckers. From this mycelium arise the short fertile threads, which are mostly clavate. The upper portion is soon separated from the lower by a septum, at which it is constricted, and this upper cell, of an elliptical shape, becomes a conidium. Whilst this process is going on another septum is developed at an equal distance below the first, and another conidium is differentiated. This process goes on until a chain of conidia is produced from the original branch, the apical conidium being the oldest, and hence the first to separate itself from its companions, and so the rest fall away in succession until they form a thin stratum of conidia on the surface of the mycelium in readiness to be transferred by wind or rain to other and healthy leaves. Upon reaching its new location the conidium germinates by the production of a tube near its extremity, and this germ-tube is the initial stage of a new mycelium. This is the asexual reproduction, by conidia, of the *oidium* condition of the Erysiphei, of which the ordinary European vine mildew and the Australian *Erysiphe viticola* are examples. Later in the season the threads of the mycelium produce a more complex form of fruit. A globose receptacle, of a yellowish colour at first, is to be seen here and there upon the white mycelium. It seldom exceeds a small pin's head in size, and ultimately becomes brown or black. The outer membrane, or perithecium, remains attached, and is soon surrounded with more or less distinct radiating flexuous threads or appendages, which vary according to the genera. Internally the perithecium encloses one, two, or more hyaline pear-shaped sacs, or asci, which contain the sporidia. When mature the perithecia split irregularly, and the asci, with their sporidia, are ejected. Each sporidium is elliptical, hyaline, and capable of germination, the germ threads becoming a new mycelium. This is the ascigerous, and probably *sexual* reproduction.

The whole career of these epiphytal parasites is therefore external and superficial, and, if they can be destroyed by powdering or spraying, the leaves may recover their vigour; but if not, by the destruction of the conidia or sporidia, or by their germination being prevented, the disease is held in check, and its extension to other leaves or other plants rendered impossible. The cultivator who possesses sufficient elementary knowledge of the fungi to determine whether the pests he has to deal with are of this nature is already in possession of the power to treat them effectually. Even the very crude method of picking off the diseased leaves and burning them will limit the area of infection.

More important and more destructive are the *endophytal* parasites, which originate within the tissues of the host plants, and only manifest themselves externally, when it is too late to save the plants. The "rot moulds" are of this kind, such as the potato mildew, American vine disease, tobacco mildew, and many other devastating pests. They are called "rot moulds" because of the rotting of the leaves and stems subsequent to their attacks. Their scientific designation is *Peronosporaceæ,* and they have the habit and appearance of white moulds, but are parasitic on living plants. Here again it is of the utmost importance to know something of their life history and methods of reproduction before they can be combated with success. The mature mould, when it appears on the surface of a diseased plant, produces a profusion of spores or conidia. Each conidium is an elliptical colourless body, having a thin outer coating of membrane with fluid contents. These contents soon become granular, and at length collect at three or four centres, which condense and soon become distinctly separated from each other by the growth of a special envelope. Ultimately the membrane of the mother cell is ruptured, and the three or four smaller bodies, which have been differentiated in its interior, escape, each one furnished at one extremity with a pair of delicate movable hairs, by means of which these little bodies, now termed *zoospores,* can swim actively in any thin film of moisture upon which they may fall. Possibly this film may be upon the leaf of a foster plant. In a short time all motion ceases, and the zoospores come to rest, the pair of delicate cilia are absorbed, and a germinating thread is produced, the point of which seeks out and enters at one of the stomata of the sustaining plant. Having once obtained an entrance, the thread grows vigorously, and a little mass of threads, called a *mycelium,* is soon developed within the tissues, capable of spreading itself through the plant which it has infected. In the next stage we discover that this mycelium has developed erect branched threads, which pass out through the stomata again into the external air, sometimes singly, sometimes in tufts. These are the fertile threads of the mould, which soon produce a single conidium at the tip of each of the branchlets, just like the original conidium whence the zoospores were developed. When fully matured each fertile thread produces a score or more of these conidia, which fall away when ripe, and then undergo transformation into zoospores, ready and active, prepared to pass through the same stages again, and indefinitely multiply the pest. This history represents the ordinary conidial fructification of the mould, by means of which it is passed from leaf to leaf, and from plant to plant, until the whole area is affected. How many of the minute conidia may be transported to a considerable distance by a breath of wind it is impossible to say, but it is known that they may be carried to any spot where there is sufficient moisture for the conidia to be differentiated into zoospores, and afterwards come to rest and germinate. This process takes place in summer and autumn, but there is yet another means by which the pest is disseminated in spring.

The mycelium which flourishes within the substance of the plant infested is capable of producing larger globose bodies, chiefly within the stems, concealed from external view. These globose bodies secrete a thick envelope, mostly of a brownish colour, and after development they remain in a state of rest within the stems during the winter. So that old stems of plants, which are infested with the mould during the autumn, conceal within themselves during the winter a large number of these "resting spores." As the old stems rot and decay the resting spores are set free in the spring, and then a period of activity commences. The contents of these globose bodies become differentiated into a large number of zoospores, which ultimately escape, by a rupture of the thick envelope, armed with vibratile cilia, and in all respects like the zoospores which are developed from the conidia. These active zoospores swarm over the damp soil, and are carried by the spring rains into proximity with the young seedling leaves of the new crop of host plants; then the cilia are absorbed, germination commences, the delicate threads of mycelium enter the nearest stomata, and infection results. In this way, in addition to the spread of the infection from conidia in summer and autumn, provision is made for an attack upon seedlings in the spring. It will be inferred that, in order to check the spread of these diseases, the conidia must be destroyed in the autumn, to prevent their extension to healthy plants; and the destruction of all rotting *débris* must be carried out during the winter, so as to extirpate all the concealed resting spores, and thus prevent the infection of seedlings in the spring.

From these details it will be evident that plants once attacked by endophytal parasites are in themselves hopeless. No external application can destroy organisms which it cannot reach, or, if they could be destroyed, no manipulation can replace the disorganised tissues. Hence, then, all efforts should be directed towards the destruction of the conidia and resting spores, in order to stamp out the disease at its source, and prevent the future infection of healthy plants. The application of spraying to plants apparently without disease would be done as a preventative, in order to destroy at once any germs which might be brought into contact with the foliage; and the destruction of all infected material would limit the local sources of infection. With an intelligent appreciation of the objects which have to be attained, the cultivator may accomplish a great deal in the way of prevention, even though he may be helpless to effect a cure. It will be seen how much of this depends upon an accurate diagnosis of the disease.

There are many other forms of endophytal parasites, and the life history of some of these is still obscure. In the majority of them only a conidial fructification is yet known, and the internal tissues do not appear to be so absorbed and destroyed as in the case of the "rot moulds"; but in such black moulds as the "apple and pear scab" the mycelium appears to be perennial, and produces a fresh crop of conidia each successive year. There is some evidence that this disease is deep seated and hereditary, and, if so, it is doubtful whether any amount of external application will result in a perfect cure. The genus *Glœosporium* includes many species which are very destructive, but often they seem to be localised, and the mycelium may not pass internally to other parts. This can only be ascertained by closer investigation.

The little pustules on the leaves and the fruits are seated beneath the cuticle, where a cushion or stroma of compacted mycelium produces conidia, but without any enclosing membrane or perithecium. When the conidia are matured, the cuticle is ruptured, and the spores escape to the surface, in many cases adhering in a somewhat gelatinous mass, which oozes out in the form of tendrils. In such cases it is evident that the application of some fungicide capable of destroying the vitality of the conidia will be of service in preventing the spread of the disease

A large and important group of endophytes is that known as the Uredines, of which the common and disastrous "wheat rust" or "wheat mildew" is an example. We have given a brief outline of their life history elsewhere,* and it is only necessary to allude here to the persistency of the teleutospores in some of the species. These teleutospores are produced within pustules on the green parts of plants, and are at first covered by the cuticle. On arriving at maturity the cuticle is ruptured so that the teleutospores may escape. In certain species they escape almost immediately as a dark-brown powder, and germinate at once. In othes species they form a compact mass, which remains adherent to the matrix, and in that condition they rest for a long period, probably through the winter, in a state of hybernation, and germinate in the spring. It will be evident at once that the destruction of these clusters of teleutospores will minimise the spring infections, and hence that they should be well looked after and destroyed either by effective fungicides or by burning up all the dead leaves and stems of the foster plants known to have been affected. In this case, again, we must suggest the importance of acquiring some practical knowledge of the history and mystery of such plant parasites, if they are to be encountered and vanquished in their career of destruction.

In this connection we cannot omit alluding to the evidence, which is gradually accumulating, of the connection between these minute organisms the Microbes, or *Schizomycetes*, and plant diseases. There are certain diseases which attack cultivated plants and produce disastrous results, which have long been a mystery, since, although the host plants appeared to be suffering from the attacks of some insidious fungus disease, none of the usual external appearances could be detected. In several cases of this kind it has been affirmed, although not yet completely confirmed, that the disease is caused by the presence of a minute *Bacterium* or *Bacillus* in immense numbers. There is no reason, analogically, why this should not be the case, and all the evidence seems to strengthen the probability; but the suggestion is so recent and the investigation so difficult that it would be imprudent to hazard any very decided opinion. Researches into a vine disease in California, a melon disease in some parts of the United States, and the very prevalent "peach yellows" almost establish the fact that microbes are present in large numbers, and are, hypothetically, the cause of the disease. In reference to the disease of cucumbers and melons, it has been claimed that the disease is accompanied profusely by bacteria; that the juice of diseased plants swarming with these organisms when transferred to healthy plants will inoculate them with the disease, which will make its appearance in three or four days;

* Handbook of Australian Fungi—Introduction, p. xxii.

that seed watered with the juice of diseased fruits did not germinate, or only 25 per cent. germinated at all, and these soon decayed; that the diseased juice when introduced into healthy stems and fruits of tomato rapidly produced decay; that young tomato plants in proximity with diseased cucumbers were all destroyed. Hence it is concluded that the disease in question is caused by bacteria, and may be transmitted to other plants by inoculation. If all this should be confirmed, then we shall have to deal with another class of plant diseases of fungoid origin, which will require a different mode of treatment, and doubtless offer a stubborn resistance.

From the foregoing observations it will be manifest that there are such broad distinctions between different groups of pestiferous fungi that they should not all be subjected to the same mode of treatment, and that the remedies which might be successful in cases of one kind would be powerless in another. Hence, then, modes of treatment must have a relation to the known character of the parasite. It follows from this that a certain amount of knowledge of the life history and affinities of the parasite must precede any definite effort to counteract or destroy it, as in animal diseases an accurate diagnosis must precede treatment. Such being the case, it is important to consider what means can be employed to diffuse the necessary information amongst cultivators, so as to enable them to determine the general character of the disease. This does not imply the specific identification of the fungus, which would be the work of an expert, but the general characteristics only, and especially whether the disease is caused by an endophyte or an epiphyte. After this, presuming it to be an endophyte, whether it is related to the rot-moulds, the forms of Anthracnose as represented by species of *Glæosporium*, or to the "rusts" or Uredines, the cultivator in possession of the power to determine thus much for himself might easily learn what remedies have been most successful in similar cases, and apply them systematically with some hopes of success.

In countries where there is any extensive culture of fruits or vineyards as a commercial enterprise the Departments of Agriculture there are sometimes found to apply themselves to a limited extent to the dissemination of information or the acquisition of reports on the chief diseases to which the culture is liable. These should naturally be the centres of activity for such purposes, but experience has shown that they are apt to ignore vegetable parasites until such pests have passed into an extreme stage, when they are exceedingly difficult to combat. Self-help is more important and effective than official aid, and the stimulant to self-help may be furnished most effectually by the diffusion of useful knowledge in such a form and in such a manner that the culturist may be able to recognise at once the attacks of disease, ascertain its character, and oppose checks to its progress before it becomes an established pest. It seems to us that such departments as we have alluded to, or some similar central authority, would be well employed in perseveringly disseminating such elementary information as we have suggested in these observations, or any suggestions which might enable the culturist to recognise a fungus pest, to determine its character, and to apply remedies intelligently and systematically. It should not be difficult to furnish a "guide" for the use of fruit-growers everywhere, which should set forth the various known diseases in this category, their life history as far as has been determined, the circumstances which are favourable to their development, and the remedies which have been tried. Such a work would be a sort of "domestic medicine" for vegetable diseases, and would be a manual for self-help in all emergencies. Although the Germans have two or three works of repute which would serve this purpose, there is none, unfortunately, in the English language which covers the whole ground, or touches other than field crops, or extends beyond an agricultural interest.

This communication cannot pretend to do more than to touch the fringe of a most important subject, and to urge it upon the attention of all who are interested in the success of the vineyards and orchards of Australia. Specific and detailed information would have been out of place, and could not have been circumscribed within the necessary limits, besides which it is not so important, in the first instance, as those general characteristics which determine the nature of the parasite, and the direction which remedial efforts must assume.

We are driven to a reiteration of the old adage that "knowledge is power," and to make its application to pestiferous fungi a final argument, since it will be evident, from the very nature of the pests, that the individual who has possession of the elementary knowledge necessary to discriminate the differences between an endophyte and an epiphyte will have a great advantage over one who does not possess such knowledge, and will be ready to take action at once, without waiting for extraneous help, meanwhile permitting the parasite to establish itself, to the increase of its power. It is matter of history that prompt action, when made in the proper direction, may save a crop; but such action presupposes knowledge, and in proportion to the extent of that knowledge will success follow its application. "I speak as unto wise men, judge ye what I say."

2.—PECULIARITIES OF THE PHANEROGAMIC FLORA OF QUEENSLAND.

By F. M. BAILEY, F.L.S., Government Botanist, Queensland.

I. Introductory remarks.
II. Change of character, habit, or structure probably due to climatic influences.
III. Distant habitats within the colony.
IV. Representatives of genera usually only found in countries distant from Australia.
V. With regard to peculiar habit.
VI. Indigenous fruits recommended for cultivation.
VII. Variegation amongst Queensland plants, including naturalised species.
VIII. Colour supposed to be abnormal.
IX. Plants recently found to contain highly poisonous properties.
X. Nodules.
XI. Naturalised and strayed plants.
XII. Deciduous trees.

I.—INTRODUCTORY REMARKS.

My intention in preparing the present paper has not been to furnish a general review of the Flora of Queensland. My object has rather been to make a few remarks upon some of what might be termed the remarkable features of the Flora in regard to distribution, habit, stature, properties, &c. An extensive territory like Queensland, with a seaboard of about 2,500 miles, would lead one to expect a rich and varied flora, and such indeed is the case. Few countries have plants of more intrinsic value, whether viewed in an æsthetic or economic sense. The fodders are almost innumerable, and include some hundreds of kinds of most nutritious grasses. The woods number probably 1,000 sorts, amongst which are those suitable for all conceivable purposes for which this material is used. The barks of many are rich in tannin, while the foliage is rich in fragrant oils, which, with the exudent gum and resin, have become articles of export. It may be here aptly mentioned that within the last few months my friend Dr. Jos. Lauterer has found that the young twigs and foliage of *Cinnamomum Oliverii* yield a good percentage of a camphor identical with that obtained from the Chinese tree, *Cinnamomum camphora*. Few indeed are the plants of our indigenous Flora which may be termed really hurtful to stock or dangerous to man. A large number, however, are considered by the bushman and country settlers to possess medicinal virtues, and some few have been extolled by the medical faculty. In food plants and edible fruits also Queensland is not far behind any other country; persons, however, are apt to compare these wild fruits with those in cultivation, and overlook the immense amount of time, care, and skill which has been bestowed upon our cultivated plants to bring them to their present state of perfection. Even in the wild state many of the indigenous fruits are of great service to the settlers, who convert them into excellent jam for home consumption, and probably those now in use are inferior to many met with in the bush far from settlement, and thus only known to travellers through unfrequented parts, such as the scrubs bordering the Northern rivers and mountain ranges. The portion of our continent now known as Queensland has been a favourite hunting-ground for the botanist since Banks and Solander collected along the banks of the Endeavour; yet, although much has been done to collect specimens of our plants, so rich is the Flora in species that one can but consider that a mere skimming of the number has been collected. Persons who do not know the country would probably think that most of the important plants are known; such, however, is not the case, for frequently specimens of new timbers, fruits, and fodder are received, especially from the Northern districts. These reach the botanist for determination, the people being generally fully aware of the folly of trusting to local names alone.

With these few remarks upon our Flora generally, I will now pass on to point out, under separate headings, something of the peculiarities of the plants. Besides the many new species which are becoming known as the colony is further and more carefully explored, the botanist has from time to time to correct or furnish additional matter to the descriptions which have been already published. In like manner it must be understood that some of our later names and descriptions, like those of an earlier date, must be taken as provisional. It may be asked, Why name until a full and complete description can be published? The answer is,—That a name, and as full a description as possible, becomes at once necessary, to distinguish the plant from others, and afford the means of intelligibly communicating one with another about it. I will therefore, in the first paragraph, refer to a few instances where the character, habit, or stature of plants has been found to differ widely in what appears to be the same species though gathered in far distant localities.

II.—CHANGE OF CHARACTER, HABIT, OR STATURE PROBABLY DUE TO CLIMATIC INFLUENCES.

The remarkable difference in character, habit, or stature which one meets with in the same species, when found in far distant habitats, is worthy of remark. Indeed, so distinct do these plants appear that one need not be surprised at botanists having at times given to them distinct specific names, and afterwards allowing such names to lapse. I, however, think it advisable, if only for convenience' sake, that all forms or varieties, when at all pronounced, should bear distinctive names. An extraordinary instance of this change of character takes place in *Strychnos psilosperma*, F. v. M. Until recent years this species was considered to be confined to the tropics, and there to form a large rambling shrub or small crooked-stemmed tree. But, when collecting woods for the Colonial and Indian Exhibition, I found this species not uncommon in the Brisbane scrubs, and always forming straight erect trees, 60 or more feet in height, and a diameter of trunk about 12 inches. Similar trees I have since met with in the scrubs at Eumundi. It must, therefore, be conceded that this southern plant is the normal form, and that met with in the tropics only a depauperated growth or form, for I find no botanic distinction. The only reason which can be given for this tree having escaped detection so long is probably due to its resemblance to *Carissa ovata*, the leaf being small in the southern tree and the fruit seldom met with on small specimens. The grasses, *Setaria glauca*, Beauv., and *S. macrostachya*, H. B. and K., are other examples where the tropical representatives are of a much smaller growth, and which might well be known as named varieties. We usually expect to find the tropical form to be more robust or the foliage and fruit to be of larger size, and such is indeed the case with some of our plants. Take, for instance, the inflorescence of *Cenchrus australis*, R. Br. No one, who for the first time was shown specimens of the southern and northern forms of this grass would take them to belong to the same species. In the case of the Red Ash—*Alphitonia excelsa*, Reissek—the foliage is often very dissimilar; but where such is not the case the tropical fruit is fully twice the size of the southern. The same also takes place in the fruit of *Eupomatia laurina*, R. Br. In the She Pine—*Podocarpus elata*, R. Br.—the foliage of the northern tree is several times longer than the southern. In the above examples the species are met with in different localities, reaching from the southern to the northern limits. But there are some curious instances where the habitats of a species, so far as at present known, are some hundreds, perhaps 1,000 miles apart; and these in some cases have received distinctive specific names, as, for example, the Davidsonian plum—*Davidsonia pruriens*, F. v. M.—the well-known useful fruit of tropical Queensland, and *D. Jerseyana*, F. v. M., found on the southern border of Queensland and in the adjoining scrub lands of New South Wales. It seems to me that size of foliage and fruit is the principal distinction between these two plants; and I may remark that on southern-grown plants of the northern tree the fruit never attains more than half the size it does upon the trees in Northern Queensland. *Acronychia acidula*, F. v. M., is a small tree met with on the borders of the tropical scrubs, and not again, so far as I am aware, until we find it near the Logan River. This has never thus far received more than the one specific name; yet the difference between the northern and southern tree is quite as much marked as in the Davidsonias. The foliage and fruit of the tropical tree are much larger; the fruit also is of very irregular form. The southern fruit has a much more agreeable acid flavour, and is of an even, globular shape; the leaves also are of a brighter green. This form was first discovered by the late Rev. B. Scortechini, and might safely bear his name as a variety of *A. acidula.*

III.—DISTANT HABITATS WITHIN THE COLONY.

I will now refer to one or two of our plants which are at present only known from far distant localities, but in which no change of character has been observed. Being probably a very rare tree, I notice *Erythroxylon ellipticum*, R. Br., first. That excellent botanist, Dr. Robert Brown, was the discoverer of the plant, which he found, at the beginning of the present century, on the mainland opposite Groote Eylandt, in the Gulf of Carpentaria No other specimens seem to have been obtained, either there or elsewhere, until I received some from the Walsh Range, a distance probably of 500 or 600 miles from Dr. Brown's habitat. This botanist describes the plant as a shrub of about 5 feet high, but probably he could not spare time to look about, or he might have met with some plants of a larger growth; for my correspondent at the Walsh Range describes the tree as attaining a height of 35 feet, with a stem diameter of 12 inches. I have received logs from the locality exceeding this dimension.

A Pomaderris, which I take for an apetalous form of *P. phillyreoides*, Sieb., is met with around Stanthorpe, on the Glasshouse Mountains, about Herberton, and on Walsh's Pyramid, a mountain at the Mulgrave.

The wiry grass, *Rottboellia rariflora*, Bail., has yet only been met with at the Batavia River and about the Musgrave Station, Cape York Peninsula; this latter locality is also the only Queensland habitat of *Elæocarpus arnhemicus*, F. v. M., although the tree has been met with in several parts of the Northern Territory, South Australia, as well as in New Guinea. From the above station on Cape York Peninsula I have also received specimens of *Owenia vernicosa*, F. v. M., the only other places where this tree has been met with being Cambridge Gulf, Western Australia, and the Northern Territory of South Australia.

Graptophyllum spinigerum, F. v. M., so far has only been met with in two localities—the Endeavour River and the Eumundi scrubs, which are about 1,000 miles apart.

One of the most remarkable instances of the wide distance between the habitats of some of the Queensland plants is the meeting with trees of the "Stringy-bark Pine," *Callitris Parlatorei*, F. v. M., on the Bellenden-Ker Range in 1889, for prior to this the tree was thought confined to New South Wales and the ranges of the Southern Queensland border.

That beautiful variety of the leafless terrestrial Orchid Dipodium, *D. punctatum*, var. *Hamiltonianum*, is so far only known from three very distantly separated localities—viz., the islands of Moreton Bay, Stanthorpe, and in one part of New South Wales.

IV.—REPRESENTATIVES OF GENERA USUALLY ONLY FOUND IN COUNTRIES DISTANT FROM AUSTRALIA.

Under this head I shall only refer to plants which have been brought under our notice during recent years. As the most distant, two South American genera may be first noticed—viz., Omphalea and Bursera. The first of these, *O. queenslandiæ*, Bail., is a rampant climber in the scrubs of the Johnstone and Russell rivers. It bears a large globose fruit, containing from two to four round nuts, which abound in oil, and are only eaten by the natives when fresh gathered. The second plant, *B. australasica*, Bail., by some known by the name of "carrot-wood," is a tree of considerable size, met with in the Eumundi scrubs. The next most interesting addition to our known flora is a species of the Mexican genus, Zinnia, *Z. australis*, Bail., found near the Walsh River.

One need not feel surprised at meeting in Queensland with some of the following plants, the only wonder is that they have not been found earlier, for some are plants enjoying a wide range through the world, and others are well known in India, or are species of genera indigenous to India or countries nearer to Australia.

Carpesium cernuum, Linn.—A plant met with in several different countries; has been found in a few localities in Southern Queensland. When I first published this as indigenous to Queensland, certain botanists took exception, for some reason unknown, considering the plant as an introduction; but from the localities in which it has been found, there is not the least doubt that it is truly indigenous; indeed, were we to reject this plant then a large number of others would have to be eliminated from our flora.

Oxalis (Biophytum) *Apodiscias*, Turcz., is another instance of a plant which is to be met with in several distant parts of the globe, being also indigenous in Queensland, but, so far as at present known, confined to one locality—Musgrave, Cape York Peninsula.

Boehmeria macrostachya, R. Wight.—An Indian shrub; has so far only been met with in Queensland in one locality—viz., a creek running from Tambourine Mountain. Here, however, it was found some few years ago in great luxuriance. Another instance of a plant being found in Queensland which had previously only been known from a distant region is the meeting with fine specimens of trees which Dr. Rumphius described and figured in Herbarium Amboinensis as *Cassia fistula*, var. *silvestris;* for an account of which see my Third Botany Bulletin, page 11, where it is given as *C. Brewsteri*, var. *sylvestris*. So far as at present known the only Queensland habitat of *Uncaria ferrea*, DC., is the scrubs bordering the Mulgrave River. This tall climber, however, is common in India. In passing, I may remark that Dr. Thos. L. Bancroft found the leaves of this plant to contain "Gambier" similar to that obtained in India from other species of the genus. This Queensland plant should find favour with our cultivators for producing the above astringent, which is used in tanning and medicine, and, mixed with dammar oil and applied to wood, is said to preserve it from white ants and dry rot; thus there should be a local demand for the produce.

The Order Rosaceæ is but poorly represented in Australia, and its tribe Pruneæ until recently altogether unrepresented. It is a great pleasure, therefore, to the botanist to find amongst the scrub trees at the Barron River one of the genus Pygeum, a new species described in my Botany Bulletin VIII. as *Pygeum Turnerianum.* In this locality has also lately been met with that curious Olacineous climber, *Cardiopteris lobata*, the Queensland plant being the variety *moluccana*, which so closely resembles a yam (*Dioscorea*) as to have been labelled in an European herbarium as *Dioscorea sativa.*

V.—WITH REGARD TO PECULIAR HABIT.

Some of our small trees or tree-like shrubs have such a peculiar mode of growth that it may not be out of place to refer in this paper to an example or so, some of which, however, when better studied may prove well-marked varieties or even distinct species. I would first refer to the Queensland nut, *Macadamia ternifolia*, F. v. M. In the southern parts of the colony this forms a fine, handsome, erect tree, fruiting pretty regularly year after year; whereas at Maroochie, say, about 70 miles north of Brisbane, what appears to be the same species has a very different habit of growth. Here the plant sends up several stems from a hard, broad, irregular, rhizome-like base; and as these stems attain the height of from 15 to 20 feet and bear a crop of fruit, they are said to die away somewhat similar to herbaceous plants, the next stems in age and size taking their place. I have seen this growth myself, and was told by an old resident of the district that it was the usual mode of the nut-tree in that district. The only other instance of this habit of growth of which I have heard is recorded by Miss Lovell, of Sandy Cape, Fraser Island, who says that *Pitheco-lobium Lovellæ*, Bail., after attaining the height of from 20 to 30 feet, dies off in a somewhat similar manner, other stems from the same rootstock taking their place. I have noticed at Eumundi that something like this occurs with the closely allied species, *P. Tozerii*, F. v. M., but at the time I attributed this to the effect of a borer insect, which destroyed so many of the stems.

VI.—INDIGENOUS FRUITS RECOMMENDED FOR CULTIVATION.

Under this heading I purpose offering a few remarks upon some of the indigenous fruits. We are fully aware that to a large number of Queensland residents these native fruits are unknown, while to others they are known, used, and appreciated; and we may fairly hope that as time rolls on, and vulgar prejudice dies out, that our fruits will be allotted a place in the fruit garden, and the produce known in commerce. Useful, however, as they undoubtedly are to the settler in their wild state, we must not be content to remove these wild plants into our cultivation plots without a thought as to climate, situation, careful selection, and cultivation. Even in the bush it may be noticed that one tree produces fruit superior to another, although the trees are of exactly the same kind, and it is from such that we should obtain our plants intended for experimental cultivation purposes.

The thirty-one kinds which I bring under notice are selected from fifteen genera, and for convenience are given alphabetically according to the botanic name—viz., *Acronychia acidula*, F. v. M., Logan Apple, Order Rutaceæ. This forms a round-headed tree 20 or more feet in height, and produces an abundant crop of a sharply acid fruit of a whitish colour, nearly round, and 1 inch in diameter, which may be improved by selection and cultivation. I have also tasted excellent jam which was made at Fraser Island from the fruit of another species of this genus, *Acronychia imperforata*, F. v. M. The fruit of this is not quite so large as the last mentioned, is of a reddish colour, and imparts its colour to the preserve.

Of the Euphorbiaceous genus *Antidesma*, five of the Queensland species furnish the settlers with fruits from which excellent jam and jelly is made, viz.:—

A. Bunius, Spreng., the fruit of which is also largely used in Java, especially by the Europeans, for preserving. In tropical Queensland it is also put to a like use.

A. Dallachyanum, Baill., the "Herbert River Cherry."—This forms a good-sized tree, and produces abundant crops of fruit, which ripen about July. On different trees the size and colouring of the fruit vary a good deal, the largest being about 1 inch in diameter; they are nearly round, very juicy, and of a very sharply acid flavour. The jelly made from this fruit is quite equal to that made from the European red currant.

A. erostre, F. v. M., bears a much smaller fruit, which is used for jam and jelly making at the Barron River.

A. Ghæsembilla, Gærtn. The fruit of this species is in use at the Walsh River for jam and jelly making by the settlers.

A. parvifolium, F. v. M., is called "Currant Bush" at the Gilbert River, and is used, like all the others mentioned, for preserving, and is considered a most wholesome and agreeable fruit for the purpose.

Under careful cultivation these fruits would probably greatly improve, and become favourites with the public; but, although they will all grow and produce fruit in the Brisbane district, they are more fitted for the tropical parts of the colony.

Atalantia glauca, J. D. Hook. The Kumquat or Lime of our Downs country. Order Rutaceæ, and closely allied to the orange; often attains the size of a small tree, but while only the size of a small shrub yields a great abundance of fruit, which is gathered and converted into jam by the settlers. By careful selection and cross-fertilisation from this might be obtained varieties worthy of cultivation for the sake of their fruit.

Species of the closely allied Citrus family are—*C. australis*, Planch.—the round-fruited Native Orange or Lime, which in some of our mountain scrubs forms quite a large tree, with fruit 2 or 3 inches in diameter; and *C. australasica*, F. v. M., the Finger Lime, whose fruit is frequently as much as 4 inches in length, with a diameter of $\frac{3}{4}$ or 1 inch. The variety of this species—*sanguinea*, Bail.—only so far as at present known to be met with on Tambourine Mountain, differs from the normal form in the colour of its fruit, which is blood-red throughout. These long fruits differ from the round in having a thinner rind, and the acid being of a more delicate flavour.

C. inodora, Bail., "The North Queensland Lime," which so far has only been met with in the scrubs about the Russell River, differs in its foliage, which has a greater resemblance to the cultivated species; its fruit is over 2 inches long, and $1\frac{1}{4}$ inches in diameter; the rind is thin, pulp juicy and of a sharply acid flavour. Even in the wild state it is a desirable fruit, and takes the place of the cultivated lemon.

Davidsonia pruriens, F. v. M., "The Davidsonian Plum," is a small tree of graceful, erect habit, belonging to the order Saxifrageæ, which in tropical Queensland bears an oval fruit the size of a goose-egg, the outside of which is covered with short stiff hairs; these, however, are easily removed by a slight rubbing with a rough cloth, and then is exposed the smooth purple plum-like skin of the fruit; the interior is composed of a few flat, irregularly-shaped seeds, embedded in a soft fleshy pulp of a rich purple colour and a sharply acid flavour. The seeds are small for the size of the fruit, a feature not frequently occurring in wild fruits, but not uncommon in tropical Queensland. This plum, which is in perfection about July, is largely used by the settlers for making into jam and jelly, as well as an addition to pie-melon or pumpkin, to which it imparts an agreeable acid and rich colouring. By careful selection and cultivation this fruit might become a valuable addition to our cultivated kinds, but it is more suited to the tropical parts of the colony than the southern.

Diploglottis is a genus of Sapindaceæ containing two species, or one species with a well-marked variety. The first known is the large southern tree, more commonly called "Native Tamarind," *Diploglottis Cunninghamii*, Hook. The second species or variety is only met with in our tropical scrubs; this is *D. diphyllostegia*, F. v. M. It is a tree of much smaller growth, and retains a very largely distinctive appearance when grown with *D. Cunninghamii* in our southern gardens; its fruit is also smaller, and there is a slight difference in the time of the ripening of the fruit. As usual in this order, the part of the fruit used is the juicy aril surrounding the seed, which is of a fleshy consistency, and possesses a sharply acid flavour, well suiting it for jam or jelly, for which purpose it is frequently used by settlers. The flavour of the preserve, when carefully made, is delicious, well repaying all the labour bestowed upon its preparation.

Eugenia, a large genus of the order Myrtaceæ in Queensland, furnishes several species whose fruits are used by the settlers for jam and wine making. Some of the kinds have received distinctive local names, as the "Endeavour River Pear," *E. eucalyptoides*, F. v. M. This forms a handsome small tree with drooping branches and long narrow leaves. The fruit is pear-shaped, about 1½ inches long, and a diameter of over 1 inch at the larger end, rosy on the side exposed to the sun, the rest of a pale colour nearly white. The flesh is abundant and well-flavoured, and used by the settlers in the district where it grows for jam-making.

E. grandis, Wight, called "White Apple," is a large tree of tropical Queensland, which bears a great quantity of round, white, somewhat insipid fruit, 2 inches in diameter. This is used for jam-making by the settlers.

E. hemilampra, F. v. M.—During July and August trees of this species may frequently be met with in the Eumundi scrubs laden with fruit, which is well-coloured and sharply acid, and worthy the attention of settlers for jam and jelly making. A description of the tree is given in my Botany Bulletin No. 9.

E. Johnsonii, F. v. M.—Hitherto this species has only been met with in one locality in tropical Queensland. Its fruit has a subacid, aromatic flavour, and it is said to attain an inch or more in diameter, so when better known is likely to be utilised as the other kinds are.

E. myrtifolia, Sims., "The Scrub Cherry," is a small or large tree of Southern Queensland, which about August produces a large quantity of pretty red-coloured fruit of an agreeable flavour. This is collected and frequently utilised for jam and wine making. In September, 1894, fruit was abundant at Eumundi.

E. Tierneyana, F. v. M., and *E. Wilsonii*, F. v. M. (two tropical species), are largely used for jam-making in the districts where they grow.

The above six indigenous species are quite as well worthy of cultivation as such fruits as the well-known Brazilian Cherry—*E. uniflora*—which one meets in most Queensland gardens.

Amongst the forty kinds of our indigenous figs many are found with large fleshy fruits; but, unfortunately, these are so frequently infested with insect life as to unfit them for food. One, however—*Ficus gracilipes*, Bail.—is less troubled by insects, and is used for jam-making. The tree is of graceful habit, and an abundant fruit-bearer; the figs are nearly globose, about 1 inch in diameter, and prettily speckled, and the jam and jelly made from it are well-flavoured and sightly.

Garcinia.—This important genus of the order Guttiferæ was not known to have any representative in Australia until trees were found fruiting on the Bellenden-Ker Range in February, 1889; and even now, although another has been described by Baron Mueller from specimens received from the Coen River, fruit alone of the first—*G. Mestoni*, Bail.—is known. This fruit is of a depressed globular form, attaining 3 or more inches in diameter, very juicy, and of a pleasant flavour. This is really a most valuable addition to our list of indigenous fruits, and one that should be brought under cultivation. The tree is of much more graceful habit than is usual in plants of this genus; the stem is slender, erect, the branches somewhat drooping, and the leaves somewhat like those of the willow. Some fruit of what may prove a third species was brought by Mr. A. Meston from near the same locality last year.

Leptomeria acida, R. Br., a broom-like shrub of the order Santalaceæ, is often abundant on the sandy lands of the coast and adjoining islands, and bears a small currant-like, acid fruit, which is often gathered and converted into jam by settlers living near where the plant grows wild. This plant is one of the earliest that was so used by the Australian colonists.

Nephelium.—Of the many Queensland species of this Sapindaceous genus, only one—*N. Lautererianum*, Bail.—deserves rank as a fruit. The part made use of is the fleshy aril which surrounds the seed. It is of a pale yellow colour, and has an acid flavour and agreeable taste, closely resembling the same substance which encloses the seed of *Diploglottis*, and like that makes a most delicious preserve. Neither, however, are likely to become articles of commerce on account of the care and labour required in gathering and preparing for use; but, as they form an additional delicacy for the table, we may hope to find this, amongst other indigenous fruits, utilised by the jam manufacturer.

Rhodomyrtus macrocarpa, Benth.—The fruit of this small tree is sometimes called "Native Loquat" or "Finger Berry," and is ripe about August. It is very similar to the *Eugenia*, and used for the same purpose.

Rubus rosæfolius, Linn., "The Queensland Raspberry."—The fruit of this plant is constantly used by the settlers in all parts of the colony where the plant is to be found. In flavour it is usually very insipid, but seems to be better in the tropics. Careful selection and cultivation would likely improve this plant, but I would again suggest, what I recommended many years ago, that it should be cross-fertilised with the cultivated kind—*R. Idæus*. When this was attempted, years ago, near Brisbane, it was found that the two kinds were not in flower at the same time, and that the cultivated plant did not thrive. But now with quick railway communication no difficulty would be found in obtaining perfect flowers of the cultivated raspberry from the cool parts of New South Wales in fresh and perfect condition for fertilising the flowers of the wild plant. The cross being thus obtained, we might hope to have the sound constitution of the wild plant with some of the rich flavour in the fruit of the old plant of cultivation. Perfection must not be expected at once, but by patience and perseverance I am confident that after a while a variety will be obtained nearly if not quite equal to the best cultivated kinds, and suitable to the Queensland climate.

Schizomeria ovata, D. Don., a small tree of Saxifrageæ, produces a fruit well worthy of attention. This plant forms a large shrub or small tree. In the month of March, on the borders of scrubs in the Eudlo and Eumundi districts, the trees are seen laden with fruit, which is white, about the size of a cherry, juicy and acid.

Vitis.—This genus of the order Ampelideæ is represented in Queensland by about fifteen species. Settlers utilise the fruit of several for making jam and jelly. Those considered to be best suited for the purpose are *V. acetosa*, F. v. M., *V. nitens*, F. v. M., *V. opaca*, F. v. M., and *V. hypoglauca*, F. v. M.; the fruits of these being larger, more fleshy, and less acrid than others, although where these are not met with other species are used for the same purpose. By referring to my Botany Bulletin V., 10, it will be seen that I there expressed the opinion that two species are confused in the descriptions of *V. acetosa* given by Mr. Bentham and Baron von Mueller. That such a mistake should occur is not to be wondered at, for it is seldom that the describing botanist has good specimens of this genus to examine; these plants disarticulate so very freely in drying, and collectors' notes when given are often vague. Questions of this nature affecting our indigenous plants can never be satisfactorily settled until we have properly conducted botanic gardens—that is to say, gardens under the direction of botanists who have received horticultural training. Then these difficult, puzzling plants would be grown, their life history studied, and the results recorded for general information. Mr. Gardiner, of the Walsh River, when forwarding me specimens of *V. acetosa*, says that the bunches of this grape attain from 1 lb. to 2 lb. in weight when the plants are met with upon limestone country, and that the berries are large, with the appearance and pleasant flavour of the cultivated grape. Baron von Mueller recommended the trial of this vine in Victoria many years ago; but while there may be some doubt of its thriving so far south, there can be none as to its usefulness in tropical Queensland.

In the hope that some enterprising fruit-grower may be led to devote some little time and attention to improving and utilising our indigenous fruits, I am induced to extend somewhat this concluding paragraph upon the subject. The first object to have in view must be the improvement of the fruit, both with regard to size, productiveness, and flavour. The general austerity of even the best will have to be greatly reduced before we may hope that they will be received into cultivation. The first steps towards attaining these results will be a careful selection of the fruits from which to raise the first plants to experiment with, after which careful cultivation and further selection must be carried out under intelligent direction. Even by these means there is reason to hope that much may be achieved before resorting to cross-fertilisation. And this leads me to remind those who would experiment with our indigenous kinds of Vitis that, when referring to the wonders accomplished by the American fruit-growers in regard to the wild grapes of America, we must remember that the species which they (the Americans) have operated upon are much more closely allied to the grape of cultivation in Europe, *Vitis vinifera*, than those representing the genus in Australia. All ours belong to those formerly placed by botanists under a separate genus, named Cissus, differing as widely from the true Vitis as the American genus Ampelopsis, which the botanists of the present time also place under Vitis. I only make these remarks to show that the American had fewer difficulties to contend with in improving the character of his native grapes than fall to the lot of the Australian experimentalist. Yet there is no reason why we should be disheartened or dissuaded from this work, but for our encouragement look back upon the changes which have been wrought by human agency, both in the animal and vegetable kingdom—changes which baffle belief. My advice with regard to improving our indigenous grape fruit is—first, that careful selection and cultivation be carried on; then cross-fertilisation with the improved forms so obtained between themselves, and afterwards with the American and European varieties. Another important use to which these forms and varieties might be put is that of stocks on which to graft or bud the approved kinds which we desire to multiply. It is impossible to over-estimate the value of a strong, healthy stock. Plants may be found to exist upon a number of others which may be related to them, but if you would have them thrive they must be furnished with healthy roots, and plants unsuited to the climate are never really healthy, either root or branch. I would, therefore, wherever such is possible, recommend that indigenous plants be used for stocks. In this I must be understood as referring particularly to Queensland. No part of Australia is so trying to exotic plant life. At times we are subject to long droughts, when the country becomes for months, or perhaps years, little better than a barren waste, during which the roots or seeds of the indigenous plants remain dormant or die out altogether. At other times there is a superabundance of rain, and the ground becomes saturated for a lengthened period. Such extremes, it will be seen, are most trying to plants of more regular climates; therefore many exotics are found to succumb, usually more from the wet than the drought, from the root-cells at such times absorbing more liquid than could be utilised. Therefore it would seem incumbent upon us, wherever practicable, to take advantage of the indigenous plants for stocks, for by so doing we obtain a healthy root, which is of the first importance. Following up this subject, I would strongly urge upon growers of fruits of the Orange family in Northern Queensland the advantage of cultivating the Russell River Lime, *Citrus inodora*, Bail., for stocks. In habit this species approaches much nearer to the cultivated kinds than the other indigenous species of Citrus. I should much like to see this new species brought into cultivation, so that its flowers might be fertilised by pollen from the best lemons and limes in cultivation, the object being to obtain a root more suitable to the climate, and still a first-class fruit. I may also remark, in passing, that this family does not take readily to cross-fertilisation, so that a failure now and again must be expected.

While on the subject of stocks for fruit trees, I would like some of our tropical fruit-growers to obtain from the scrubs of the Barron River young plants of *Pygeum Turnerianum*, Bail., and try the experiment of grafting upon them various kinds of plums. The genus Pygeum is very nearly allied to Prunus, and should the experiment prove a success it would be of great advantage to the tropical fruit-growers; and I see no reason why a union should not take place between these two plants, as in other natural orders far more dissimilar plants are used for stocks to graft and bud upon.

VII.—VARIEGATION AMONGST QUEENSLAND PLANTS.

As this diseased condition of the leaves and stems of plants is by the florists highly prized for decorative purposes, it may be well to notice those amongst our indigenous and naturalised plants which have been observed to be so affected. There have been many conjectures, but up to the present the cause of the disease is unknown. My friend, Dr. Thos. L. Bancroft, has observed that these variegated plants are more frequently to be met with amongst the young growth which springs up after a scrub has been burnt. I have usually found it on plants in small scrubs bordering creeks and rivers. It is found to take place at times in seedlings, but more frequently it occurs upon a single shoot or branch, when, if it is desired to perpetuate the form, resort must be had to the usual modes of propagation—viz., slips or cuttings, budding, grafting, layering, &c. It is seldom that one meets in the wild bush with a whole plant or even a large portion of a plant so affected, which is probably due to the more luxuriant growth of the healthy portion outgrowing and smothering these diseased parts. The florists, however, might find it to their advantage to look up and perpetuate many of the wild forms of this kind, for the marking and colouring at times are very effective. The following few plants, which have been noticed in a wild state to bear variegated foliage, are given to assist the lovers of these curious growths in their search:—

Genera and Species, Habitat, Local or Aboriginal Name, and Order, respectively:—

Malvastrum tricuspidatum, A. Gray; Brisbane; Malvaceæ.

Hibiscus tiliaceus, Linn.; Coast; Cotton-tree, Talwalpin of the natives of Moreton Bay and Johnstone Rivers; Malvaceæ.

Corchorus Cunninghamii, F. v. M.; Enoggera; Tiliaceæ.

Acronychia lævis, Forst.; Taylor's Range; Rutaceæ.

Rubus rosæfolius, Sm.; Brisbane River; Raspberry; Rosaceæ.

Tabernæmontana orientalis, R. Br., var. *angustifolia*, Benth.; Enoggera; Apocynaceæ.

Lantana camara, Linn.; Enoggera; Verbenaceæ.

Amarantus paniculatus, Linn.; Brisbane; the leaves yellow and green; Amarantaceæ.

Trema aspera, Blume; Kelvin Grove; has also been met with on the Johnstone River; the Peach-leaf Poison Bush; Urticaceæ.

Cudrania javanensis, Trècul, var. *Bancroftii*, Bail.; Kelvin Grove and Deception Bay; has also been met with on Johnstone River; Cockspur Thorn; Urticaceæ.

Geitonoplesium cymosum, A. Cunn.; Bank of Brisbane River; Liliaceæ.

Cordyline terminalis, var. *Baileyi*, Bail.; Pimpama; Liliaceæ.

Commelyna cyanea, R. Br.; Spiderwort; Commelynaceæ.

Pollia macrophylla, Benth., var. *crispata*; Eumundi; Commelynaceæ.

Bacularia monostachya, F. v. M.; Eumundi; Midgeen, or Walking-stick Palm; Palmæ.

Archontophœnix Cunninghamii, Wendl.; Piccabeen of the natives; Palmæ. Some young plants of this palm, which were received by Mr. Soutter from Eudlo, show upon making a fresh growth variegated leaves.

Oplismenus compositus, Beauv.; Gramineæ.

Ageratum conyzoides, Linn.; Brisbane; Billygoat weed; Compositæ.

Bidens pilosa, Linn.; Brisbane; Blackfellows; Compositæ.

Galinsoga parviflora, Cav.; Brisbane; Yellow weed; Compositæ.

VIII.—COLOUR SUPPOSED ABNORMAL.

Under this heading I record some few instances, which have come under the observation of myself or of some fellow-worker, of plants found in the wild state to produce white flowers, whereas the species, from which they are but accidental sports, have, in the normal state, flowers of some dark colour. These unaccountable freaks of nature are frequently of value for garden culture, particularly as they are in some cases capable of being perpetuated by seed, cuttings, &c. I think it would be advantageous were botanists to make a rule, whenever these sports are met with, to describe and name them as varieties; this would be making a legitimate use of nomenclature, and would prove of great convenience and advantage to the horticulturist. In the Flora Australiensis instances several times occur of such plants being recorded as named varieties, as, for instance, *Utricularia cyanea*, var. *alba*. This, however, was not always carried out in that work, for we find many instances similar to this—"*Comesperma volubile;* flowers blue or rarely white." In this place, as in the former, the blue and the white flowers are borne upon two distinct plants, so, in my opinion, it would have been better had the white-flowered plant been given as *Comesperma volubile*, var. *album*. With these few remarks I pass on to mention plants of this nature which have been observed in Queensland since the issue of the volumes of the Flora Australiensis.

Genera and Species, Local or Aboriginal Name, and Order, respectively :—

Viola betonicæfolia, Sm.; Large Violet; Violarieæ. White flowering plants of this violet have been met with near Brisbane.

Hibiscus rhodopetalus, F. v. M.; Malvaceæ. A plant of this species has lately been met with at Mackay, which produced white flowers. This has been brought into garden cultivation.

Stylidium graminifolium, Sw., var. *album*, Bail.; Hair-trigger plant; Stylidieæ. Found near Cleveland, South Queensland.

Artanema fimbriatum, Don., var. *album*, Bail.; Scrophularineæ. Met with near Bundaberg by J. Keys.

Dendrobium bigibbum, Lindl.; Orchideæ. At Cape York there is said to be a white variety.

Dipodium punctatum, R. Br., var. *album*, Bail.; Orchideæ. On sandy land near the coast, near Cleveland, this variety was obtained a few years ago.

Doryanthes excelsa, Correa.; Amaryllideæ. A variety with white flowers is reported to have been met with on Mount Lindsay.

Commelyna cyanea, R. Br.; Commelynaceæ. I have not seen them, but am informed that this species has been seen bearing white flowers.

Aneilema gramineum, R. Br; Commelynaceæ. Plants of this species with white flowers have been met with near Brisbane.

Xyris pauciflora, Willd., var. *albiflos*, Bail.; Xyrideæ. A small variety found on Fraser Island with white flowers.

Other deviations from the supposed normal colours have been observed in the following:—

Clematis Fawcettii, F. v. M., var. *purpurascens*, Bail.; Ranunculaceæ. This is a form met with at Killarney, the flowers of which have quite a purplish tinge.

Elæocarpus cyaneus, Ait.; Tiliaceæ. Plants of this species have been met with near Stanthorpe with rose-pink flowers.

Citrus australasica, F. v. M., var. *sanguinea*, Bail.; Rutaceæ. This is a form found upon Tambourine Mountain, of which the fruit is blood-red.

Dendrobium Kingianum, Bidw., var. *pallidum*, Bail.; Orchideæ. Some plants of this form bear nearly white flowers.

Dendrobium undulatum, R. Br., var. *Broomfieldii*, Fitzg.; Orchideæ. The flowers of this form are of a more or less bright yellow.

Dendrobium teretifolium, R. Br., var. *aureum*, Bail.; Orchideæ. The flowers of this form found at Killarney are of a bronze or yellow colour.

Dipodium punctatum, R. Br., var. *Hamiltonianum*, Bail.; Orchideæ. Of this form, which has been met with at two very distant habitats—viz., the islands of Moreton Bay and about Stanthorpe—the ground colour of the flower is yellow.

Chrysopogon parviflorus, Benth., var. *flavescens*, Bail.; Gramineæ. This lovely and very distinct form is in some localities upon the Darling Downs plentiful. Instead of the usual purplish colour the inflorescence is of a pleasing yellow.

The mentioning of this grass leads me to express regret that neither Baron von Mueller nor Mr. Bentham could see their way to retain the names, or at least some of them, given by former botanists to the grass recorded in the Flora Australiensis as *Pappophorum nigricans*, R. Br., and by Baron von Mueller as

P. commune, F. v. M. The names discarded by these two botanists—viz., *pallidum*, *purpurascens*, *gracile*, *cœrulescens*, *flavescens*, and *virens*—would have admirably suited for the names of the several varieties met with in Queensland; and doubtless when our grasses are collected and brought under cultivation, such will be brought into use again as distinctive names for these varieties or forms.

IX.—PLANTS RECENTLY FOUND TO CONTAIN HIGHLY POISONOUS PROPERTIES.

In my remarks in the opening part of this paper, I said that our Flora contained but few plants of a hurtful or dangerous character; and although such is true, yet amongst the plants are found some possessing powerful active principles which have been proved highly poisonous. Some, indeed, are stated by my friend, Dr. Thomas L. Bancroft, in papers read at meetings of various societies, to equal in virulence that of the most deadly of vegetable toxicants. This gentleman has for some years past paid particular attention to the properties of Queensland plants, and I shall be content in this paragraph to mention some of our plants which he has found to possess poisonous properties which, it would seem, were previously unknown to have toxic properties.

Stephania hernandiæfolia, Walp., and *S. aculeata*, Bail. An extract of the roots of these, he says, is extremely poisonous; and he found that the root bark of *Cocculus Moorei*, F. v. M., and *Sarcopetalum Harveyanum*, F. v. M., also contained active poisonous principles.

Carissa ovata, var. *stolonifera*, Bail. The bark of this form he found to possess highly poisonous properties

Marlea vitiensis, Benth. Extract of the bark is described as poisonous.

Zanthoxylum veneficum, Bail. This contains a poisonous principle equal in strength, and somewhat similar in action, to strychnine. *Melicope erythrococca*, Benth., contains a somewhat similar poisonous principle which the doctor terms a protoplasmic poison.

Flindersia Schottiana, F. v. M. The bark of this tree contains a poisonous principle.

Daphnandra micrantha, Benth.; *D. repandula*, F. v. M.; and *D. aromatica*, Bail. Each contains in the bark highly poisonous properties.

Cryptocarya australis, Benth., and *C. triplinervis*, R. Br., also contain in their barks an alkaloid of great potency as a poison, which in its action resembles Curara.

X.—NODULES.

These curious wood formations, which are known to form in the bark of the olive and other European trees, have so far in Queensland been met with in the bark of few trees. The Bunya Pine, *Araucaria Bidwillii*, Hook., produces them, and, as may be supposed in a tree with a bark from 6 inches to 18 inches thick, they attain a great size. The nodule wood takes a high polish, and is very beautiful both in figure and colouring, and should command a high price for veneering work. *Araucaria Cunninghamii*, Ait., is also said to furnish them as large as cricket balls; these, however, I have not seen. They are very numerous in the bark of *Cinnamomum Oliverii*, Bail., attaining a diameter of 2 inches or 3 inches.

XI.—NATURALISED PLANTS, AND STRAYS FROM CULTIVATION.

It would take up far too much space, and be undesirable, to give in this paper a full list of the names of the plants which have become naturalised or which have strayed from cultivation, and are now found growing spontaneously upon the waste lands near settlement. But it may be here stated what proportion each quarter of the globe has furnished of the 200 or so plants constituting the naturalised portion of the Queensland Flora. Some of the plants may almost be called cosmopolitan, but the following is a fair statement:—About one-third are European, about one-third are from America, about one-fifth are Asiatics, but the African species only amount to about one-thirteenth. The plants are contributed by 46 orders, in the following manner:—35 orders furnish from 1 to 5 each, 7 orders from 6 to 10 each. The largest contributors are Solanaceæ 15, Leguminosæ 20, Gramineæ 21, and Compositæ 24.

While it is important that we should duly record all plants which from time to time may be observed to have naturalised themselves in our colony, it is of equal importance that attention be directed in the opposite direction. Have any of the indigenous plants become scarce or been lost, or have any species of the introduced ones, after over-running a portion of the country, disappeared? The only instance of this kind of which I can think is that pretty little water-weed, *Hydrocharis morsus-ranæ*, Linn. About twenty years ago this plant was most abundant in the still waters around Brisbane, but for the past fifteen or more years I have not met with a single specimen; and although it may still be plentiful in some localities, I know of no Queensland habitat of the plant, and this favours my former opinion that the plant was an introduction.

XII.—DECIDUOUS TREES

Evergreen trees predominate, as a rule, in all hot or warm climates, and we find this to be the case in Queensland. Our deciduous trees are few in number, and the fall of the leaf, in most cases, is so uncertain that the term "semi-deciduous" would be a better term to apply to them. For while one tree of a species may be found quite bare of leaves, another by its side may be seen full of leaf, with nothing to distinguish it from a purely evergreen species. The following constitutes the majority of our trees of this character, a small proportion considering that the Queensland Forest Flora cannot number less than 1,000 small or large trees:—

Cochlospermun Gillivræi, Benth.; Order Bixineæ.

Bombax malabaricum, DC., Silk Cotton Tree; Order Malvacæ.

Sterculia quadrifida, R. Br.; *S. discolor*, F. v. M.; *S. trichosiphon*, Benth.; *S. acerifolia*, A. Cunn.; Order Sterculiaceæ.

Melia composita, Willd., White Cedar; Order Meliaceæ.

Cedrela Toona, Roxb., Red Cedar; Order Meliaceæ.

Sesbania grandiflora, Pers.; Order Leguminosæ.

Erythrina indica, Lam., Coral Tree; *E. vespertilio*, Benth., Cork Tree; Order Leguminosæ.

Castanospermum australe, A. Cunn.; Moreton Bay Chestnut or Bean Tree; Order Leguminosæ.

Albizzia procera, Benth.; Order Leguminosæ.

Eucalyptus platyphylla, F. v. M., Poplar Gum; Order Myrtaceæ.

Sarcocephalus cordatus, Miq., Leichhardt Tree; Order Rubiaceæ.

Ficus colossea, F. v. M.; *F. Cunninghamii*, Miq.; Order Urticaceæ.

3.—ON THE FERTILISATION OF SOME AUSTRALIAN PLANTS.

(1 Plate.)

By A. G. HAMILTON, Public School, Mount Kembla, New South Wales.

PITTOSPOREÆ.

Pittosporum undulatum, Andr.—In the majority of trees the flowers are proterandrous, the anthers being well developed and full of good pollen. The flowers are very attractive to insects, from their powerful sweet scent and free secretion of nectar. But in a small proportion of trees the anthers are small and short, and the pollen does not appear to be functional, in addition to which the anthers do not dehisce. They are very closely adpressed to the base of the ovulary, and secrete nectar. The flowers of this form are also sweet-scented. These short anthers vary much in size, even in the same flower, and I think it probable that the trees are in a state of transition towards separation of the sexes. As I stated in a note read before the Linnean Society of New South Wales in September, 1893, I have not been able to find any record of this; but Mr. E. Betche, to whom I pointed out the circumstance, and who verified it by observation on the trees about Sydney, pointed out the following passage to me in Engler and Prantl's "Natürliche Pflanzenfamilien" (1):—"The large coloured flowers (of Pittosporeæ), the sweet smell, and secretion of honey in many flowers indicate fertilisation by insects; but very few actual observations have been recorded. Mr. Thomson records, in Trans. and Proc. of the N. Z. Inst., 1880, that the flowers of *Pittosporum tenuifolium* are proterogynous, and that *P. eugenioides* inclines to separation of the sexes." It is very interesting to have this confirmation of the facts above stated from New Zealand.

The flowers of both forms are much frequented by bees, both native and introduced, and by butterflies, especially the Pieridæ and *Papilio Macleayanus*, and fruit very freely.

Fig. 1 shows the ordinary form of stamen and ovulary; Fig. 2, stamens and ovulary in form having short stamens; while Fig. 3 is a semi-diagrammatic representation of a short stamen, showing the position of the pollen, which is undeveloped and abortive.

Citriobatus multiflorus, Cunn.—In this plant the anthers and stigma mature simultaneously, and this fact and the minute size and inconspicuous colour of the flowers indicate that it is self-fertilised, a view which would seem to be confirmed by the large number of flowers which develop fruits. But, on the other hand, the presence of nectar and the very sweet scent would point to the agency of insects.

Although I watched some plants closely, I did not observe that any insects paid systematic visits to the flowers. It is probable that, if not cross-fertilised, the position of the anthers crowded closely round the stigma conduces to self-fertilisation.

MELIACEÆ.

Synoum glandulosum, Juss.—In this plant there are four white petals; the eight stamens form a tube, and are slightly cottony on the inner surface. The stigma is disc-shaped, and almost touches the anthers with its edge in young flowers, but afterwards grows up slightly above them. The ovulary is hairy. The flowers have a strong, rich scent, especially in the evening, and attract multitudes of butterflies, moths, bees, flies, and beetles. Among the butterflies frequenting I have observed *Casyapa beata* (which I think must be crepuscular in its habits, as I never saw it before twilight), *Papilio Macleayanus*, *P. erectheus*, and several of the Pieridæ and Hesperidæ. It is probably insect-fertilised, but some hitch evidently occurs, for a tree near my house bore continuously large quantities of flowers from September, 1892, till August, 1893, and during that period was constantly visited by insects, yet it did not bear a single fruit. Another in a more retired situation bore flowers for about a month, and was less visited by insects, yet it is now so loaded with fruit that the limbs bend downwards. Yet examination of the stigmata in the first plant showed that they were all smeared with a mixture of pollen and a glutinous liquid, probably secreted by the stigma. Microscopic observations, however, failed to show that any pollen tubes were emitted. The buds are sometimes infested with the larvæ of a small beetle, which feeds on the pollen, and drops to the ground to undergo metamorphosis.

MALVACEÆ.

Pavonia hastata, Cav.—This plant bears cleistogamous flowers during the spring and summer months, which always ripen seed. But in the hotter part of the summer very attractive crimson and white flowers open in quantities, and are fertilised by bees and beetles which visit them frequently. These flowers do not invariably bear seed.

Hibiscus heterophyllus, Vent.—I merely mention this species because, although it bears large numbers of conspicuous, white and crimson, scented flowers, I have never yet seen it visited by any large insects, and it is not much frequented by smaller ones. Its large white sweet blossoms seem to point to fertilisation by night-flying insects; but here (Illawarra, N.S.W.) it usually opens very early in the morning, and withers before night. It invariably bears seed, so that it is probably visited by some insects; but, so far, I have failed to detect them. The flowers open most freely on a misty cool day succeeding a very hot one.

STERCULIACEÆ.

Commersonia Fraseri, Gay.—The flowers, which are exceedingly numerous, are strongly proterandrous, but in addition to this they are well provided with contrivances to prevent insects going from the anthers to the stigma of the same flower. The petals are much widened at the base, forming wings, and these curl over so as to make a tunnel to the fertile stamens, which are five in number. Each fertile stamen is connate with three spathulate staminodia, the middle one being much wider than the others. The five wide staminodia lean backwards towards the centre of the flower, and twist round each other in the earlier stages of flowering, so as to completely cut off all access to the pistil. But when the pollen is all shed from the fertile stamens, the staminodia uncurl and lean forward, leaving the way to the stigma open. Nectar is secreted at the bases of the anthers, and between the anthers and base of the ovulary, so that insects are attracted to flowers in both stages. But in proportion to the vast number of flowers the production of fruit is very small. Each tree, of course, bears a large quantity of capsules, but still not more than 3 or 4 per cent. of the blossoms can be fertilised. Indeed, in this tree I have been especially struck by the great waste of attractive power. It bears large quantities of flowers, attractive from their colour, scent, and nectar, and yet only so small a proportion as above ever fulfil their object. In another tree of the same natural order—the Flame Tree (*Sterculia acerifolia*, Cunn.), the same thing occurs. When in flower the tree is a mass of scarlet, and yet I have seen half-a-dozen trees without a single pod. When about to flower the Flame Tree loses all its leaves, or all but a belt round the bottom. The Black Currajong (*Sterculia diversifolia*, G. Don.) also usually loses the greater part of its foliage before flowering. Both are popularly supposed in this district to flower but once in seven years, but observation does not bear this out, some flowering at irregular intervals, and others every two or three years. I have not been able to connect their flowering with any prevailing or previous meteorological conditions.

EUPHORBIACEÆ.

Ricinocarpus pinifolius, Desf.—This is a monœcious plant, and usually the male flowers are much more numerous than the females. Of course such flowers must be cross-fertilised. So far as my observations go, beetles of the genus *Anaplognathus*, which frequent the plant to eat the petals, are the agents of fertilisation. Some time ago I observed some dozens of plants in flower, and very few of them had their petals complete. The beetles I took on the flowers were all more or less smeared with pollen.

LEGUMINOSÆ.

Goodia lotifolia, Salisb.—Sir John Lubbock (2) thinks that all the Leguminosæ are fertilised by bees, and gives Delpino's classification of the flowers into four groups, viz.:—

1. Those in which the pressure of the bee forces out a certain quantity of pollen, the flower resuming its original position when the weight is removed.
2. Those in which the stamens protrude as well as the pollen, the flower resuming its position here also when the insect leaves.
3. Those in which the flower bursts on pressure and ejects pollen.
4. Those in which the pressure of the insect causes a brush on the end of the pistil to sweep out the pollen.

To the second of these divisions the species under consideration belongs. When a bee (and the small native bees are most effectual in the work, being best adapted in size to the flower) alights on the petals, it stands across the wings and keel with its feet resting on the wings. It then inserts its proboscis at the base of the standard, and forces it in; the pressure from this causes the wings and the keel, to which they are locked by a projection, to be depressed, and the anthers and pollen emerge and dust the bee on the underside of the abdomen. In older flowers the style is lengthened after all the pollen has gone, and the pressure leaves that bare, so that it takes the pollen from the underside of the insect.

Kennedya rubicunda, Vent.—In this species, which belongs to Delpino's first series, the process is exactly the same, but a larger bee is necessary, and in every instance where I have observed the process it was done by a hive bee. Indeed, it is extraordinary to what an extent the hive bee has taken up the position of fertiliser-in-ordinary to native plants. And, on the other hand, native insects are rapidly and effectually adapting themselves to introduced plants. In the natural order under consideration there is an introduced plant—the Red Clover (*Trifolium pratense*)—which is said by Darwin to be only fertilised by humble bees in Europe (this is, I believe, disputed by Delpino); for, the hive-bee's proboscis not being long enough to reach to the bottom of the flower, that insect bites a hole at the base of the flower to reach the nectar. And when Red Clover was introduced into New South Wales and failed to perpetuate itself, the natural inference was that it was on account of the absence of humble bees. This view was strengthened by the fact that in New Zealand, where humble bees are acclimatised, the Red Clover seeds freely. Attempts have, therefore, been made to establish the humble bees in New South Wales to ensure the spread of this valuable fodder plant. But, prior to these attempts being made, I observed that the Red Clover had established itself at Mount Wilson, in the Blue Mountains, New South Wales; and on mentioning the fact to Mr. Fred. Turner, botanist to the Agricultural Department, he informed me that he knew of its being established in other localities. Since then the manager of one of the south coast estates in New South Wales has stated in the columns of the *Daily Telegraph* that the Red Clover is well established there without the aid of bees. I am inclined to think that climatal influences have, perhaps, a great deal to do with it, and that the plant would be more likely to establish itself in a moist and even climate such as prevails on the south coast or at Mount Wilson. Certainly in a dry and warm climate the bees could scarcely establish themselves, and so, if they are necessary, the plant would fail in such a place. How much climate has to do with flowering, &c., may be seen in the following instance:—All over the Illawarra district the Coral Tree (*Erythrina indica*, Lam.), is much used as a shade and ornamental tree. About Wollongong the trees flower very profusely, and about a month earlier than they do at Mount Kembla, some 600 or 700 feet higher. And at about 1,200 feet they rarely flower at all. Both at Wollongong and Mount Kembla the flowers are much frequented by birds (*Acanthorhynchus* and *Ptilotis* chiefly), and yet they never bear seed. Although I have carefully put pollen on the stigmas from the same and from different individual trees, yet I never succeeded in getting it to seed. Yet I believe it seeds freely on the northern rivers and in Queensland.

PROTEACEÆ.

Stenocarpus salignus, R. Br.—This flower is proterandrous, the anthers opening in the bud, and the pollen coating the stigma (which is, however, not yet functional) thickly. The posterior sepal opens and lets the style bend outwards, recalling the Goodeniaceæ in that respect. Then the other sepals gradually open and curl away. There is a large gland at the base of the style which secrets nectar freely, and the flower emits a most delicious odour. Insects feeding on the nectar rub off the pollen from the stigma, especially from the conical point, which is its most active part. The sepals usually fall off before the stigma is mature, but, as the nectar is still secreted and the other flowers attract by their scent, these flowers are visited by pollen-bearing insects, and so are fertilised. I am at a loss, however, to account for the fact that of two trees, equally free flowering, one will produce large quantities of fruits, and the other few.

Telopea speciosissima, R. Br. The flowers produce very large quantities of nectar at certain stages, so that, if a head is shaken, a shower of drops is thrown off. They are much visited by *Acanthorhynchus* and other honey-eating birds, yet they rarely produce seed; but when a plant does, it usually develops a large number. In one instance I observed a head which was much damaged by some larvæ, and this head afterwards developed several capsules.

CAMPANULACEÆ.

Wahlenbergia gracilis, DC.—Mr. E. Haviland (3) has given a good account of the fertilisation of this plant. The anthers dehisce introrsely in the bud, and in contact with the style, which bears several large glands (Fig. 11), secreting some glutinous liquid, causing the pollen to coat the outside of the style. The style then rapidly lengthens and snaps off the filaments, and the anthers dry up and drop out of the flower when it droops at night, or are carried off by the wind. The bases of the filaments are broad and cover the top of the ovulary, and under these nectar is secreted. From these facts Mr. Haviland concludes that the flower is cross-fertilised by insects. I am able to add to this that the agent is usually a small black bee, and these insects not only board at the expense of the plant, but also lodge in it at times. I have seen as many as six sleeping in one bell at night. I should not have referred to this plant at all had I not observed that it has two forms of style, a fact I have not hitherto seen recorded, although I saw in the herbarium of the Sydney Botanical Gardens specimens of both forms collected by Mr. E. Betche. In one the style is short, so that the extremity is barely level with the mouth of the bell before the lobes unfold (Fig. 4), while in the other form it is thinner, and projects considerably beyond the mouth (Fig. 5). This suggested dimorphism to me, but careful observation and experiment failed to show that it had anything to do with the fertilisation. It was, however, connected with other variations in the plants. Most of the long-styled plants have few and very narrow linear stem-leaves, while the short-styled plants have many stem-leaves, varying from narrow lanceolate to lanceolate, with rounded tips. The long-styled form is deeper, the petals narrower, and the whole flower usually smaller than in the other. The lobes of the stigma are narrower, and there are less glands on the style. The stigmatic lobes, when straightened out, measure from one-third to one-half of the rest of the style (Fig. 6), while in the other variety the lobes are as long as the remainder (Fig. 7).

The tube of the corolla in the long-styled flowers has five rows of long cottony hairs (Fig. 10) reaching over so as to touch the style; but this character, though it generally occurs, is not constant. These hairs often catch and retain much pollen, and thus form a means for self-fertilisation if cross-fertilisation fails, as the lobes of the stigma bend back into the hairs. The percentage of long-styled forms, as determined from gatherings of some hundreds of flowers at various times and in different localities, is 58·8, and of short-styled 41·2.

The plant is remarkably variable, but, undoubtedly, these may be taken as the two main varieties. The following are some of the directions in which it varies:—

1st. In size of plant and flower. A specimen in my herbarium is about 1 inch in height, and the flower is barely $\frac{1}{12}$-inch across.

2nd. In the number of parts. Sepals and petals may be 4, 5, 6, or 7, and one well filled-in double flower was observed. Anthers may be 3, 4, or 5. The stigma may have 2, 3, or 4 divisions.

3rd. The style may be long or short.

4th. The inside of the corolla may be hairy or glabrous.

5th. The calyx may be downy or glabrous.

6th. The leaves vary in being broader or narrower, and hairy or glabrous.

7th. The free limbs of the corolla vary in breadth.

8th. The colour of the corolla is white, pale blue, deep blue, and rarely pink, and the outside is white, faintly blue, or rusty buff.

So far as my observations go, I believe the small-flowered variety reproduces itself constantly, as I have known clumps of it for years in one place, close to colonies of the large-flowered variety. But the small variety is more common on poor, dry soils; and I have not observed it on the uplands near the sea, where the large variety flourishes.

The flowers close in the evening and on cloudy days, and then, by a bending of the stalk immediately below the ovulary, hang with the corolla mouth downward.

CANDOLLEACEÆ.

Leewenhœkia dubia, Sond.—I have never succeeded in making an observation of the actual process of fertilisation in this plant; but, with the aid of a knowledge of the method in *Candollea* (4), I have formed a theory which I give here, in the hope that some member of the association who has the opportunity will observe the plant and publish his results. The flower consists of five petals, four of which open in the usual position, while the fifth, which is folded into a slipper-shape, hangs down the side of the tube, and is irritable. The stamens and style are united in a column which stands up in the middle of the flower. The anthers are strongly proterandrous, and hide the stigma till all the pollen is shed. Then the stigma enlarges and becomes mature. I imagine the process to be as follows:—An insect alights on the flower, and in probing the tube for nectar touches the irritable petal, which then flies up and imprisons it against the style. The only means of exit is by climbing to the top, and even if there is no opening there the insect would go upwards. While on the top of the column it is smeared with pollen, and after a time the hood slowly drops to its normal position and sets it free. Should the insect then visit a flower with a mature stigma, the same course of events happens, and in endeavouring to escape the pollen is smeared on the stigma. The insect must be a small one, and probably is winged, as the plant is thickly covered with sticky trichomes to prevent access of crawling insects.

ACANTHACEÆ.

Eranthemum variabile, R. Br.—The front petal forms a landing-place for insects, and is marked by spots of deep colour as guides to the tubular throat of the flower. The stem is covered with hairs pointing downwards, mingled with a few glandular hairs; the calyx is very thickly covered with glandular hairs. After the seeds develop, however, these trichomes wither on the part below the fruit, but remain plump above it. The tube of the corolla is full of nectar. There are 2 anthers which are proterandrous, and 2 staminodes, which are very small, entirely hidden in the tube, and, so far as I can see, bear no part in the process of fertilisation. When the flowers first open, the anthers stand close together—almost touching—and overhang the mouth of the tube, so that no insect can insert its proboscis without rubbing against the pollen. At the same time they hide the stigma and prevent its being touched from the front; at this stage the lobes of the stigma are not unfolded. When the anthers have shed all their pollen they move apart sideways and slightly backwards, and the style then bends forward so as to fill the space occupied by the anthers before, and insects visiting the flower must of necessity rub against it; at the same time the stigmatic lobes unfold. The plant must be fertilised by insects with a proboscis long enough to reach the bottom of the tube, and the one most commonly doing it is a small day-flying moth. But I have also observed small pollen-eating beetles on the flowers, and they may possibly also act as fertilisers. It invariably bears seed for every flower. Darwin mentions the genus in a list of plants bearing cleistogamous flowers, but I have never seen anything of the kind in this species.

VERBENACEÆ.

Clerodendron tomentosum, R. Br.—In the paper on this plant, referred to before (4), I mentioned the sphinx-moth, *Deilephila celerio*, as being the insect which ordinarily fertilised this plant. But this year I have observed *Macroglossa errans*, *Chærocampa Oldenlandiæ*, *C. Scrofa*, *Macrosila casuarinæ*, and *Protoparce convolvuli* in numbers round a tree. The latter, however, from its great length of proboscis ($4\frac{1}{2}$ inches in one specimen which I measured), is able to suck up the nectar without its body coming into contact with the anthers or stigma. All the others carry away pollen on the underside of thorax and abdomen.

ORCHIDEÆ.

Dendrobium speciosum, Sm.—Mr. R. D. Fitzgerald (5) says this plant is fertilised principally by an insect, *Stethopachys formosa*, which frequents the plants to eat the leaves. But I think the colour of the

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flower, the scent, and the massing together of the blooms point towards adaptation to some special insect or insects. My reason for including it is to give some account of the method by which it is fertilised, and to point out why so few flowers usually are fertilised. In the majority of flowers the labellum hangs down loosely in front of the column (Fig. 12), and insects can alight on labellum and search for nectar, or gnaw the ridges of the labellum without touching the anthers or pollinia. But now and then a spike may be found in which the labellum clasps the column (Fig. 13), and then the only mode of access to the column or ridges is by a small chink (*a*, Fig. 14). Any insect putting its head in here presses the anther downwards, so that the pollen is protected; but on withdrawal it lifts the anther upwards, and then the pollinia adhere to the intruder and are carried away. Now, it is significant that, when a spike of flowers is discovered with the labellum clasping the column in this way, almost all the pollen masses will be found to be removed. The fact of so few flowers being found in this state accounts for the rarity of seed capsules on the plants. How rarely they do produce seed Mr. Fitzgerald has shown in the place referred to. In one instance 7 capsules to 4,200 flowers, and in the other 9 to 9,000. A remarkable thing about the rock-lily—and indeed many other Australian plants is the fact that some years all the plants flower very freely, while in other years they do not flower at all, or very few do so. Mr. Fitzgerald gives 1889 as a year in which there were many flowers. This year (1893) I think every plant in Illawarra must have flowered. A clump of plants, which had no flowers during the previous two years, in October last had 456 spikes of bloom, many spikes having 100 or more flowers. The average would probably be 80 flowers to a spike, or 36,480 flowers. In all this large number only 152 seed capsules were found, and it is noteworthy that there were no column-clasping labella among all these.

I omitted, in speaking of the flowers which have the labellum closed round the column, to say that in a spike I took in this condition —80 flowers in all—78 had pollinia removed, 20 had pollen on stigma, which had swelled up as it does when fertilised, and the ovulary had swelled also, while 36 more had pollen on stigma, and 24 had stigma unfertilised. In many of these the ridges on the labellum were gnawed away.

Lyperanthus Burnetti, F. v. M.—This orchid was collected at National Park by Mr. L. Stephenson, and at Mount Kembla by myself. Mr. E. Betche informs me that Mr. Stephenson's specimens were yellowish inside; mine were pure white. The plant is, I believe, self-fertilised, as some I isolated from insects developed seeds for every flower. It closes its flowers at night, and indeed it is only on the brightest and hottest days, and then only for a short time, that it opens them fully.

Caladenia.—Mr. Fitzgerald (6) is of opinion that the plants of this genus are fertilised by rather large insects being carried against the column by the spring of the labellum, and he witnessed the process in *Caladenia alba*, a housefly being jerked against the column, and in its struggles to escape it withdrew the pollinia. For several reasons I am inclined to think that flies are the agents, in some species at least. I once collected *Caladenia cucullata* near Guntawang, and noticed that it had a strong and most disagreeable odour, resembling decaying skins, or the castor of a horse. As the plant was new to me, I collected a large bunch, and wherever I went I was followed by numbers of blowflies, which always took every opportunity of alighting upon the flowers. This year I had a bunch of *Caladenia carnea* on my table, and I noticed the same strong smell, especially on hot days; it was also much frequented by flies, and although I did not actually see the fertilisation take place, yet it must have happened, as quite a number of flowers were fertilised, and the ovularies swelled and developed just as when fertilised in the natural state.

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5. Fitzgerald, R. D. :—"Australian Orchids," vol. ii., pl. 4.
6. " " " " vol. i., pt. 1.

EXPLANATION OF PLATE.

Pittosporum undulatum, Andr.
- Fig. 1. Stamen and ovulary in ordinary form × 6.
- Fig. 2. Stamens and ovulary in short stamen form × 6.
- Fig. 3. Short stamen showing position of pollen × 20.

Wahlenbergia gracilis, DC.—
- Fig. 4. Flower with unopened stigma, short style.
- Fig. 5. Flower with unopened stigma, long style.
- Fig. 6. Short style, stigma lobes open × 6.
- Fig. 7. Long style, stigma lobes open × 6.
- Fig. 8. Glands on lower part of style × 20.
- Fig. 9. Scars where glands have dropped off on upper part of style × 20.
- Fig. 10. Section of flower showing hairs lining corolla.
- Fig. 11. Style, lobes open, showing glands and hairs on style.

Dendrobium speciosum, Sm.—
- Fig. 12. Section of column and labellum, showing ordinary pendent position.
- Fig. 13. Section of column and labellum in clasping position.
- Fig. 14. Column from behind, showing labellum clasping it; *a*, opening by which insects have access to pollinia.

4.—AN UNDESCRIBED SPECIES OF CHARON, WITH NOTES ON THE METAMORPHOSIS OF THE FIRST PAIR OF AMBULATORY LEGS INTO A PHYSIOLOGICAL PAIR OF FEELERS.

By Dr. JOSEPH LAUTERER.

The genus Charon was established by Karsch in 1879 from a fragmentary specimen, and was founded principally on the formation of the maxillary palpi, resembling those of the *Scorpionidæ*, but ending in movable claws instead of chelæ. L. Koch, the editor of the Spider fauna of Australia (or rather Australasia), received a fragmentary specimen of Charon from Upolu which he described as *Ch. australianus*, mentioning that the first pair of ambulatory legs had been broken off. I got a specimen of the same species from Mr. Tryon, where the left leg was preserved, and only lately I had the fortune to catch a specimen of a Charon near Brisbane under bark with the first pair of legs intact. These legs are nearly double as long as those of the second pair. They do not possess anything of the character of ambulatory legs. The chief segments are still to be seen, but the tibia consists of not less than 26 movable segments, and the tarsus is composed of smaller segments of the same nature, amounting to 49; so that the whole leg is composed of 78 segments, resembling as nearly as possible the antennæ of an insect or of a crustaceous animal, ending in a decided point, and presenting every appearance of a sensorial organ of feeling, and evidently doing the same service as the antennæ do to insects, and the palpi to the other Arachnidæ. The Queensland species when walking keeps this first pair of legs elevated and stretched out horizontally, moving now and then the right or the left one to one or to the other side.

As the maxillary palpi of the genus Charon are not used for feeling or grasping, but only for defence or aggressive purposes, the animals of this genus, mostly walking in the dark, have to employ the first pair of legs in the capacity of feeling organs, and the first pair of legs was transformed into a pair of feelers, of course not from a morphological point of view, but only physiologically corresponding to feelers of insects.

I give now the generic and specific characteristics of the new species, which I call—

Charon Annulipes, n. sp.

Cephalothorax obcordate, with 2 big eyes and 2 small ones on each side. Abdomen ovate, with 7 ring segments and 4 tracheæ, destitute of a stinging tail. Maxillary palpi formed into 2 thick claws as long as cephalothorax and abdomen together; the last and second last phalanx of these on the medial side provided with 3 immovable stinging thorns. First pair of ambulatory legs nearly double as long as the other pairs; femur much thinner than the femur of the other legs, and double as long. Tibia divided into 26, tarsus divided into 47, movable rings.

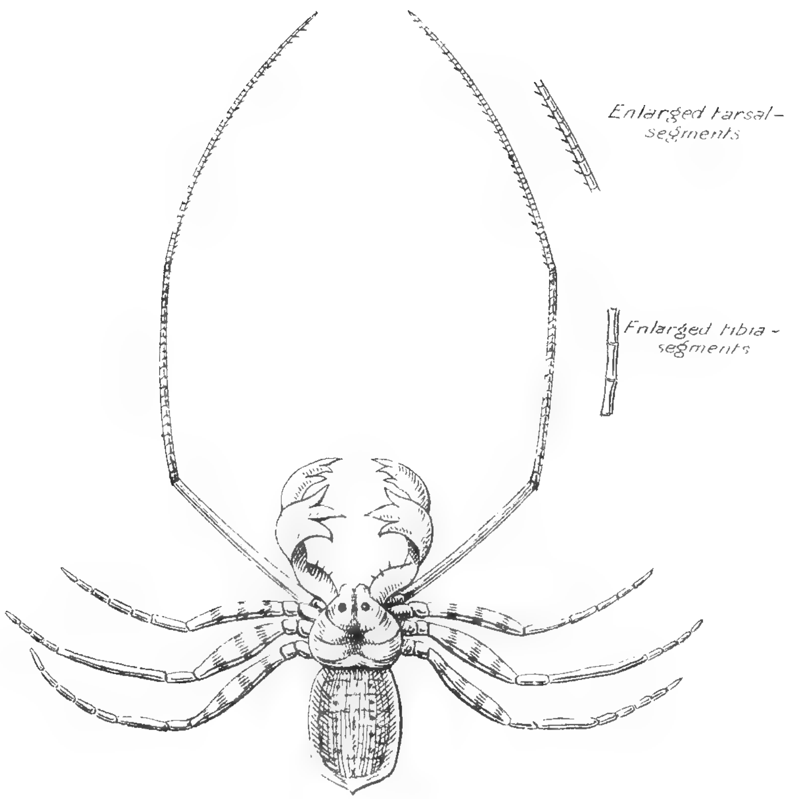
Charon annulipes measures from the point of the claws to the end of the abdomen 29 mm.; length of claws 12 mm.; of the cephalothorax 5 mm.; of the abdomen 10 mm. Length of first pair of legs 35 mm.; of second pair 20 mm.; of third pair 22 mm.; of fourth pair 20 mm. Colour of the body light-brown; of the legs light-brown, with dark-brown rings, about 4 on one leg. Habitat under the deciduous bark of gum trees. Only one specimen could be obtained of this highly interesting animal, the legs of which are quite without a parallel in the whole class of Arachnidæ.

5.—NOTES ON *DENDROLAGUS BENNETTIANUS* (De Vis), THE TREE KANGAROO.

By DUDLEY LE SOUEF.

The general proportions of this animal seem stouter than most other members of the family. Its fur is long, rather coarse, and on the nape and upper part of the back is directed forward, and forms a kind of crest of fur. Its general colour is greyish-brown, being darker in the centre of the back; its snout and chin black, face greyish, forehead reddish-brown, with light patch of grey above the eyes; nape and upper portion of the back light reddish-brown, which

Plate LII.



Charon annulipes n. sp.

Note. Drawing one half larger than natural size.

Dr.

extends on the underside of the neck; ears short and brown externally, and covered with fairly long reddish-grey hair internally; chest light greyish-brown; sides and belly a slightly darker hue; the backs of the fore and hind feet black; tail long and thickly furred, forming a tuft at the extremity, its under surface black, upper side brown for about half its length, except a black patch near its base, when it all gradually merges into black. The soles of the fore and hind feet are bare and with a very rough skin. The claws of its fore feet are long and well curved, whereas those of its hind feet are shorter and stouter; both are black in colour. Its head and body is about 2 feet long, and its tail 3 feet. These animals vary slightly in colour, the old specimens often having a silvery-grey appearance on their sides and head, and the young are more of a reddish hue, which darkens as they reach maturity. They are very plentiful in the scrub-covered mountain districts near Cooktown, North Queensland, and seem to live on the higher part of the ranges, probably because the timber is smaller and more easy to climb. They seem unable to ascend or descend the trunk of a large tree, and those found in such places get up by means of the various large creepers that often hang in festoons from the tree top. Those in captivity will ascend an upright 3-inch gaspipe with ease and very quickly, moving their hind feet simultaneously. Wherever it is possible they always move their hind feet with a jump, clinging on and climbing with their fore feet. It is wonderful how they keep their balance when out near the end of a slim branch which is swayed about by the breeze. When they do occasionally lose their balance they still cling on to the bough, and work their way down on the underside of the branch until they are able to right themselves. When descending a large branch they let themselves down backwards by their fore feet, and let the hind ones slide, but when descending a small branch they move one hind foot at a time. When feeding on the leaves they pull down the ends of the branches to them to secure their food, and in that way are enabled to get at almost any foliage that may be on the tree, although one would say that it was impossible for them to secure it. When wanting to get on to a branch below them, they generally go to the end of the bough, where their weight makes it bend considerably; they then cling on with their fore feet, let the hinder portion of their body hang down until they are enabled to secure a footing on the branch beneath, when they let go the upper bough. They seem to use considerable judgment in so doing. Their movement among the branches is extremely active; they can jump a considerable distance from one bough on to another, and the roughness of the skin of the sole of their feet evidently prevents them from slipping. Occasionally the branch which they are on breaks, and down they come; but they always appear to land on their feet, and seem none the worse for their tumble. They can jump a considerable distance to the ground from the tree. On one occasion I was climbing up a huge granite boulder by the aid of the roots of a species of fig, with which it was embraced, and when almost at the top I found a tree kangaroo sitting on a bough among the leafy foliage about two feet away from me; it was evidently enjoying its siesta. On being disturbed it jumped off its perch on to a small rock which was showing above the tangled mass of creepers, orchids, &c., fully 40 feet below from where the animal was sitting; it quickly jumped from rock to rock down the steep mountain side, and disappeared in the dense scrub. The long bushy tail is not prehensile, and when on the tree it always hangs straight down; but when on the ground they generally turn it upward like the shape of a boomerang, and keep it clear from the ground, their body leaning well forward to balance it, and occasionally they let it rest on the ground; but in common with all other kangaroos the tail does not touch the ground when hopping. The reason of its being so long is evidently to act as a balance when jumping from one branch to another. I have noticed that the rock wallabies also have much longer and more thickly furred tails than those that live in the level country. On one occasion in a rocky range near Duaringa, in Queensland, I saw four of them (*Petrogale penicillata*), which, on being disturbed, made for an old leaning stump of a tree about 70 feet long, up which they quickly hopped and took refuge in its hollow interior. These animals can also hop about on th thick lower inclining branches of small trees.

The tree kangaroo passes its day near the top of a tree, generally well shaded by the thick foliage. It bends its back and places its head and fore feet well down in front and close to its body, the same way that all wallabies do, and so coiled up sleeps the greater part of the day. The tail hangs straight down, and their whereabouts is often detected by seeing that appendage so hanging and being swayed about by the breeze. About sunset they bestir themselves and commence feeding. They do not eat grass—in fact, no grass grows in the scrub where these animals live—but feed on leaves of various trees, such as the white cedar and others, also of creepers, bird's-nest fern, fruit, &c.; and those in captivity feed freely on various vegetables, fruit, and eucalyptus leaves, and soon denude the tree on which they are kept of foliage.

They seem to live almost exclusively on the trees, often passing from one to the other by means of the branches, but, when unable to do so by that means, they come on to the ground, and by so doing their whereabouts is discovered, as the dogs are enabled to track them to the tree they are on by the scent on the ground. The natives say that they do not come down to the water to drink; but as there is such a heavy rainfall and abundance of moisture in the high districts in which they live, it is quite possible that they do not, but in captivity they always take the water with which they are supplied.

When the natives wish to capture any of these animals they go to the higher parts of the mountain ranges with their dogs, and generally in the morning when the scent is fresh, and hunt about until the dog picks up the scent, which they follow up until they arrive at the tree in which the kangaroo is, although occasionally there are two or three on one tree. Some of the natives then climb the tree that may be growing near to the one on which the tree kangaroo is, to prevent it escaping on to it, while another of their number ascends the one on which the animal is, and he either catches it by its long tail or forces it to jump to the ground in its endeavours to escape. The other blacks with the dogs are there on the lookout for it and soon secure it, when it is placed in a bag brought for that purpose. Fully half of those so caught die during the first few days from injuries received, generally through having been bitten by the dogs. It requires a well-trained dog to hunt for the tree kangaroos, and there are very few that are any good for that purpose. The scent is much more difficult to follow if rain has fallen after the animal has passed over the ground. These animals are more or less infested with two or three kinds of parasites, and often have sore places, apparently caused by one of these insects burrowing under the skin. These tree kangaroos are very pugnacious, and when placed together on a tree in captivity fight very viciously, the weaker occasionally being killed. The young leave the pouch about August.

6.—NESTS AND EGGS OF THE AUSTRALIAN ACCIPITRES, OR DIURNAL BIRDS OF PREY.

By A. J. CAMPBELL.

It is with peculiar pleasure I ask the Brisbane Congress to accept this treatise of the Nests and Eggs of Australian Hawks, because they are amongst the most interesting and useful of our birds, and because we now possess information, more or less, respecting the nidification of all known Australian forms, save one—which may be filled in by analogy.

Not only have I endeavoured to give as concise a description as possible of the various nests and eggs, but I have also furnished a reference to all previous descriptions of eggs pertaining to the species under notice. The accepted geographical range of each species is likewise furnished; and I trust not the least interesting are the popular observations given, gleaned from other writers and field observers, and embodied with new and original matter of my own.

Moreover, I hope the article may be the means of stirring up Australians to a better knowledge of these noble birds, to admire and protect them as the most useful of vermin-destroyers in our land. I know the hands of our friends the squatters are against that king of hawks, the Wedge-tailed Eagle, because it takes a few lambs during a brief season, but they should remember the numbers of pestilent rabbits, in addition to other vermin, that the eagles clear off the land-owners' broad estates during the rest of the season. Again, because a good henwife loses a stray chicken now and then, are all the smaller and beautiful hawks—birds that materially aid in keeping the hordes of grasshoppers, plagues of mice, snakes, &c., in check—to be swept off the face of the country?

CIRCUS GOULDI, Bonaparte.

(Harrier or Swamp-hawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 26.

Previous Descriptions of Eggs.—Gould: "Birds of Australia," Handbook, vol. i., p. 59 (1865); Potts: Trans. New Zealand Inst., vol. ii., p. 52 (1870); Buller: "Birds of New Zealand" (1873), also vol. i., p. 212 (1888); North: Catalogue Nests and Eggs Australian Birds, p. 2 (1889).

Geographical Distribution.—Australia and Tasmania, also Lord Howe and Norfolk Islands, New Zealand, New Caledonia, and Fiji Islands.

Nest.—Built of coarse, dry herbage—stalks of thistles, dock, &c.; sometimes of sticks and twigs, and lined with short pieces of hay-like swamp or other grass. Structure is somewhat flat, about 17 cm. (7 inches) high by 40 cm. (16 inches) across. Situation, usually upon the ground amongst rank herbage, in rushes, or in grain crops, but sometimes on a low bush.

Eggs.—Clutch, 3-5; inclined to oval in shape; texture of shell somewhat coarse or porous, with the surface lustreless; in some clutches rough with small limy excrescences; colour pure white, except in cases of dirt stains received in the nest during incubation. When emptied and held up to the light the interior of the shell possesses a beautiful sea-green appearance. Eggs are apparently small for the size of the bird. A clutch taken on Pental Island, Murray district, Victoria, 4th December, 1890, measures in centimetres: (1) 5·33 x 3·85, (2) 5·29 x 3·83, (3) 5·0 x 3·85. The fourth egg is abnormally small, being only 3·75 x 2·85 cm.

Observations.—Of the birds of prey, probably the eggs of the Swamp-hawk are the most common in our collections, for the reason that the nests being on or near the ground are easily taken, whereas the general run of our Falconidæ breed aloft in some tall forest tree. Moreover, Swamp-hawks enjoy an extensive range, including many extra-Australian localities. Sir Walter Buller records that the Harrier or Swamp-hawk often returns to the same nesting-place for several successive seasons, the old nest forming a foundation for the new one, and that the young are very savage when molested, throwing themselves on their backs and striking out vigorously with their talons at the intruder.

The late Mr. T. H. Potts sent the following New Zealand note to the *Zoologist* :—"In November, 1884, in one of the large swamps in the Hind district of the Canterbury Plains, a nest of the Harrier, built on a large tuft of coarse growing rushes, was knocked over by a mob of cattle. The nest being set up again and the eggs put back, the hawk returned and resumed incubation. The nest contained five eggs. Another nest in the Hororaki district also contained five eggs."

Clutches of five have been taken also by Tasmanian collectors. Principal breeding months include September to December.

CIRCUS ASSIMILIS, Jardine and Selby.

(Spotted Harrier.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 27.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 60 (1865); North: Catalogue Nests and Eggs Australian Birds, p. 1 (1889).

Geographical Distribution.—Australia in general and Tasmania; also Celebes.

Nest.—Somewhat flat, loose structure, composed of sticks and twigs, and lined sparingly with leaves. Usually situated in a tree, but sometimes on the ground amongst herbage, when it is built after the manner of that of *Circus Gouldi.*

Eggs.—Clutch, 3-4; similar to those of *Circus Gouldi;* inclined to oval in shape; surface lustreless; colour pure white. Dimensions in centimetres: (1) 5·23 x 3·81; (2) 5·23 x 3·81; (3) 5·08 x 3·96.

Observations.—This handsomely marked hawk, although plentifully dispersed over some interior localities, is not so frequently noticed as the more familiar Swamp-hawk. It is seen occasionally in Victoria. Lately the Messrs. Brittlebank found a nest of this species in their crop near Myrniong, Victoria. But it is evident the Spotted Harrier does not always nest upon the ground, as the following interesting information, furnished by Mr. Harry Barnard, shows:— His notice was first attracted by a pair of these fine Harriers examining magpies' (*Gymnorhina*) old nests, and mating. Soon afterwards they commenced building in a silver-leafed ironbark (*Eucalyptus melanophloia*), at intervals extending over six weeks, a nest which at best was only a frail, flat structure lined with leaves. When the clutch reached the number of three the eggs were taken, the date being the end of September, 1893. Locality: Coomooboolaroo, Queensland.

Breeding month probably same as refer to *C. Gouldi.*

ASTUR CINEREUS, Vieillot.

(Grey Goshawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 14.

Previous Descriptions of Eggs.—Campbell: Southern Science Record (1883); North: Catalogue Nests and Eggs Australian Birds, p. 2 (1889).

Geographical Distribution.—Australia in general.

Nest.—Stick-made structure, lined with leaves, usually green, and placed in a lofty tree.

Eggs.—Clutch, 2-3; oval in shape; shell slightly rough or porous, with surface lustreless; colour white, with a perceptible bluish or greenish tinge, sparingly marked with a few smudges and other smaller markings of reddish-brown. The markings may be easily removed by moisture. Dimensions in centimetres of a clutch: (1) 5·13 x 3·85; (2) 5·11 x 3·84.

Observations.—Our knowledge of the breeding habits of this beautiful Goshawk is not very extensive, nor are its eggs found in many collections. Those I first described (now redescribed above) were taken (1880) by a son of my deceased friend, the enthusiastic collector, Mr. H. A. Smith, of Batesford, near Geelong.

Mr. A. J. North informs us that "the nest of *Astur cinereus* (the large continental form of the White Goshawk) is an open structure, composed of thin sticks and lined with twigs and leaves. One found near the Cape Otway Forest, Vicotria (1865), was placed in the topmost boughs of a lofty eucalyptus, and contained two eggs; in form nearly oval; slightly swollen at one end; of a dull, bluish-white, smeared and blotched with faded markings of reddish and reddish-brown, particularly towards the larger end, and which, were it not for the size, might be easily mistaken for those of *Astur approximans*, which they greatly resemble."

ASTUR NOVÆ HOLLANDIÆ, Gmelin.

(White Goshawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 15.

Previous Descriptions of Eggs.—Campbell: "Victorian Naturalist" (1888).

Geographical Distribution.—Queensland, New South Wales, Victoria, South Australia, and Tasmania.

Nest.—Somewhat flat, constructed of fine sticks broken from the extremity of dry branches, and lined inside with green eucalyptus leaves.

Eggs.—Clutch, 2-3; oval in shape; surface soft and beautiful, but lustreless; colour bluish-white, with a few large smudges and specks of purplish-brown markings, some of which are duller in colour, appearing as if beneath the surface of the shell. Dimensions in centimetres of a clutch: (1) 4·76 x 3·89; (2) 4·7 x 3·9; (3) 4·7 x 3·85 cm.

Observations.—The announcement of the finding of the nest and eggs of this lovely hawk of immaculate whiteness was first made at the October meeting, 1887, of the Royal Society of Tasmania, when the secretary (Mr. Alex. Morton) stated that Mr. Arthur E. Brent, an enthusiastic collector, had discovered on the previous day a nest containing two eggs. Subsequently the discoverer was good enough to allow me to describe the eggs, and forwarded the following information:—"Nest composed of very fine, dry sticks, broken freshly from the extreme ends of dry branches, very flat, with a few green peppermint gum-leaves forming the receptacle for the eggs, which were two. Tree, stringybark; and nest about 70 feet from the ground. The bird being very aggressive, I had to use my left hand to keep her off. I could feel the wind on my face from her wings as she flew past, and on more than one occasion her wing feathers touched my hand, she uttering a piercing cry the while. The eggs were taken on the 9th October. Locality: A dark gully on Mount Falkiner."

Subsequently another White Hawk's nest was known to Mr. Brent, from which eggs were taken two successive seasons. The nest was composed of very fine twigs from the dead branches of standing trees, which the birds settle on, break off with their talons, and carry direct to the nest. This Mr. Brent has observed. The lining of small green twigs and leaves is gathered in like manner. Although the birds laid about the end of October, in this instance they appeared to have commenced to repair their nest about the middle of September, for Mr. Brent writes: "On the 16th I started for the locality, which I reached about 8 o'clock. Secreting myself on the broad of my back in the ferns, &c., I waited the result. I had not more than twenty minutes to wait when the cries of little birds around told me of the approach of their enemy, and, looking in the direction from whence came a sound like a rushing wind, I saw high up the hill-side above me a streak in the air, which proved to be the male bird from its smaller size. It came straight for the nest at a terrific rate, shot past the nest, then took a complete circle and settled right in it, carrying in its claws two small twigs, which the bird immediately dropped, and hopping on to the side of the nest seemed to be placing them with its beak, all the while uttering a half-whistle, half-cackling noise. This I saw repeated several times, likewise by the other bird, which was also white."

Mr. Brent again visited the nest on the 4th November, when he took three eggs with incubation about ten days old. The nest resembles that of *A. approximans*, but is a trifle larger. It may be mentioned that the eggs (three) were taken the previous season, about the middle of November, by some local lads, who required as a reward £2 for each specimen. Possibly they have the eggs yet.

Astur Novæ Hollandiæ (sub-species) leucosomus, Sharpe.
(Lesser White Goshawk.)

Geographical Distribution.—North Queensland, also New Guinea and adjacent islands.

Observations.—The nest and eggs of the Lesser White Goshawk are up to the present unknown to science. Moreover, it is the only species of Australian Accipitres of which we possess no information with regard to its nidification. But doubtless in that as in other respects the Lesser White Goshawk resembles its southern and close allies, *A. cinereus* and *A. novæ-hollandiæ*, by constructing the usual stick-made nest, and laying two or three bluish-white eggs meagrely marked with brown if marked at all.

Astur approximans, Vigors and Horsfield.
(Australian Goshawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 17.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 42 (1865); Ramsay: P.L.S., N.S.W., 2nd ser., vol. i., p. 1141 (1886).

Geographical Distribution.—Australia in general and Tasmania; also Norfolk Island and New Caledonia.

Nest.—Constructed of sticks and twigs, lined with leaves, and generally situated in a lofty eucalypt or other tree, not unfrequently overhanging a stream or lagoon.

Eggs.—Clutch, 2-4, but usually 3; stout ovals in shape, but sharper at one end; surface of soft appearance and lustreless; colour bluish-white, in some instances sparingly marked with roundish blotches and spots of dark reddish-brown. In common with all goshawks' eggs, when empty and held up to the light, there appears a greenish colour on the inner side of the shell. Dimensions, in centimetres, of a clutch taken at Coomooboolaroo, Queensland, 6th October, 1885: (1) 4·7 x 3·8; (2) 4·77 x 3·73.

Observations.—This bold and dashing Goshawk is commonly dispersed over Australia and Tasmania; and, notwithstanding that it is plentiful, the different stages of plumage between young and matured birds cause much confusion as to its identification. That some of the birds breed before full livery is donned, I feel convinced.

Strolling along the banks of the Loddon River, Victoria, on one occasion, I observed a nest of the Goshawk in an overhanging tree, likewise in the same tree was a home of the white-throated heron (*Ardea novæ-hollandiæ*), and both species of birds sitting. The next nest of this Goshawk that interested me was at Coomooboolaroo, Queensland, where I witnessed Mr. Harry Barnard ascend a tall eucalypt to the height of about 70 feet from the ground, and from a nest on a horizontal forked limb abstract a pair of typical eggs, which are now in my collection—with unusually full data. Breeding months include August to December, chiefly the three last months.

There is a singular fact worthy of record that some birds lay a fuller complement of eggs in Tasmania than the same species does on the mainland. The Goshawk may be cited as an instance. On the continent two or three eggs form a clutch, while the Tasmanian collectors, Messrs. George K. Hinsby and Arthur E. Brent, almost invariably take four on their island. Mr. Brent writes:—"I have taken several nests of this interesting hawk, and have been present at the taking of others, and in every instance except one the nest contained a whole clutch of four eggs. Only three days ago (the 29th October, 1894) I took a nest containing four eggs from a large stringybark eucalypt in Glenorchy. The nest was about 80 feet from the ground, and was a flat structure of fine sticks about 18 to 20 inches across, and was lined about 8 to 10 inches across with green gum leaves, while the inside shallow basin or cavity for the eggs was about 5 or 6 inches across."

ASTUR CRUENTUS, Gould.

(Lesser Goshawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i, pl. 18.

Previous Descriptions of Eggs.—Campbell: Proc. Roy. Soc. Victoria (1890).

Geographical Distribution.—West and North Australia, and Victoria (casual).

Nest.—Constructed of dead sticks, lined inside with finer material, including probably green leaves, and placed on the horizontal fork of a tall tree.

Eggs.—Clutch, 2-3; roundish in shape, with dull or lustreless surface; colour bluish-white. One specimen in a clutch of two possesses a few smudges of reddish-brown. Dimensions: (1) 4·4 x 3·46 cm.; (2) 4·33 x 3·43 cm.

Observations.—As Gould observes, this Goshawk is an intermediate size between the Australian Goshawk (*Astur approximans*) and the Collared Sparrow-hawk (*Accipiter cirrhocephalus*). It is more particularly a western bird, but probably ranging to Northern Australia; while individuals casually reach eastern parts.

Principal breeding months are October, November, and December.

UROSPIZIAS RADIATUS, Latham.

(Red Goshawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 16.

Previous Descriptions of Eggs.—Ramsay: P.L.S., N.S.W., 2nd ser., vol. i., p. 1141 (1886); Campbell: "Victorian Naturalist" (1886); North: Catalogue Nests and Eggs Australian Birds, app. (1890).

Geographical Distribution.—South Queensland and New South Wales, and probably the interior of both Northern Territory and South Australia.

Nest.—Somewhat large, constructed of sticks lined inside with twigs and eucalypt leaves, and placed in a lofty tree, usually a eucalypt.

Eggs.—Clutch, 2-3; roundish in shape; surface somewhat rough and without lustre; colour uniform dull or bluish-white. One example in a pair has a few blotches, spots, and other irregular markings of dark-brown. Dimensions in centimetres: (1) 5·58 x 4·57; (2) 5·46 x 4·62. Two examples of a second clutch of three, which were all without markings, give—(1) 5·73 x 4·57; (2) 5·53 x 4·64.

Observations.—This rare and powerful Goshawk is an inhabitant chiefly of the interior. The eggs were first brought to scientific light by the late Mr. George Barnard, of Coomooboolaroo, Central Queensland, whose good name was, and is now through his sons, a household word amongst natural history collectors in Australia. The first and original nest was found in September, 1884, by Mr. Barnard's sons in the top of a lofty Moreton Bay ash (*Eucalyptus tesselaris*) on their cattle station. The nest contained a pair of eggs. Mr. Barnard did not allow the interesting discovery to grow cold, but at once forwarded a specimen to the Australian Museum for Dr. Ramsay to describe, while the description furnished by me in the "Victorian Naturalist" was taken from the other specimen in the collection at Coomooboolaroo.

A second nest was not found till 29th October, 1889, when a fine egg was forwarded by Mr. Barnard in an unostentatious manner, as was his quiet, unobtrusive disposition, to adorn my collection. This time the nest was built in a lemon-scented gum (*Eucalyptus citriodora*), and was constructed in a flat fork projecting straight out from the tree at a height of about 60 feet from the ground. There were two eggs in the nest; but in communicating with Mr. North, to whom he also presented a specimen. Mr. Barnard wrote:—"A rather singular occurrence took place about the Radiated Goshawk's nest. When my sons found it there were two eggs in it; and one of them shot the male. About a month after, being up that way again, one of them climbed the tree and found another egg in the nest, evidently laid after the first eggs were taken and the male shot."

The description, &c., of the eggs above given are from those two nests. A third nest was, however, found on the 3rd October, 1893, by Mr. Harry Barnard, but it contained two young ones a few days old. In this instance the nest was again situated in a large lemon-scented gum, and at a distance of 73 feet from the ground.

The breeding months of the Red or Radiated Goshawk may therefore be said to be August, September and October.

Accipiter cirrhocephalus, Vieillot.

(Collared Sparrow-hawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 19.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 46 (1865); Ramsay: P.L.S., New South Wales, vol. vii., p. 413 (1882).

Geographical Distribution.—Australia in general, Tasmania, and New Guinea.

Nest.—Sometimes large, at other times small, constructed of sticks and twigs, lined inside with fibrous material or eucalypt leaves, and situated in the forked branches of a tree usually growing near water. Frequently the nest of another bird of prey is used.

Eggs.—Clutch, 3-4; round in shape; texture of shell comparatively fine, with surface lustreless; colour white or of a bluish or greenish tinge, devoid of markings, but more frequently stained with dirt from the nest during incubation, while other examples possess a few blotches or spots of dark-brown. A full clutch found at Coomooboolaroo, Queensland, 29th October, 1891, by Mr. Dudley Le Souëf, measures in centimetres: (1) 3·9 x 3·08; (2) 3·86 x 3·14; (3) 3·85 x 3·06.

Observations.—This is the smallest of Australian hawks; but for a bold and fearless disposition, rapidity of flight, abrupt turning, and unerring aim at luckless prey, the little Sparrow-hawk far excels many of its larger compeers. Let me give an instance seen by my friend, Mr. C. C. Brittlebank: It is morn in the full flush of spring. A heron (*Ardea novæ-hollandiæ*) rises from a swamp near, and is leisurely winging its way, when behold like a streak in the distance is seen our bold little fellow, the Sparrow-hawk, heading straight for the large bird. Presently the bird of prey swoops down, and, for a wonder, undershoots its mark, caused by a strategic upward curve of the heron, but the hawk, equal to the occasion, and with a rapid turn, fairly throws itself at the large bird's wing, which breaks with a loud report. Then the poor bird commences to form spiral circles earthward, the game little hawk sticking to its quarry the while. Besides my friend, others had been watching the combat—to wit, ten or a dozen magpies (*Gymnorhina leuconota*), which now came up on hurrying wings. Then occurs upon the ground such a scene—the wounded heron hoarsely calling, all the magpies scolding and fiercely picking the screaming hawk, which has a rough time of it, and seems much relieved at Mr. Brittlebank's near approach, causing the much too pugnacious "magpies" to scatter. The hawk quickly follows, but in the opposite direction, and there is only left the stately heron with a fractured carpal joint.

I possess other evidence of the bold and desperate character of the Sparrow-hawk. A farmer friend told me how on one occasion he beheld a large white rooster in the field beheaded by the little bird of prey; while Mr. William Bateman, a duck-shooter of twenty years' experience in the Murray River district, has witnessed the hawk put on a terrific spurt to overtake flying ducks, then, suddenly making a swoop from behind on outstretched wings, deal a duck a blow that fells it dead. Twice Mr. Bateman has seen coots decapitated, and relates how he and his brother procured a bustard or wild turkey without spending ammunition. The turkey was seen to rise well out of range, and was flying away when a little hawk was observed coming up at right angles to the turkey's flight, and, making an exceedingly swift cut, clean scalped the great bird. When the sportsmen picked up the turkey it was quite dead.

Mr. Hermann Lau, formerly of South Queensland, furnishes us with the remarkable fact of the great cuckoo or channel-bill (*Scythrops*) depositing its egg in the nest of a Sparrow-hawk, or a nest, at all events, where the Sparrow-hawk had laid. In September, 1874, near Yandilla, he found the hawk's nest, which was situated high in the branches of a tree. It contained two eggs nearly incubated, but, to his intense surprise, one was evidently the large purplish-brown egg of the channel-bill, or, as it is called in the interior, the rain-bird.

The breeding season generally of the Collared Sparrow-hawk is included in the months from August to November, and possibly December.

Uroaetus audax, Latham.

(Wedge-tailed Eagle—Eagle-hawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 1.

Previous Descriptions of Eggs.—Ramsay: "Ibis," vol. v., p. 446 (1863); Gould: "Birds of Australia," Handbook, vol. i., p. 10 (1865).

Geographical Distribution.—Whole of Australia and Tasmania.

Nest.—Composed of dead sticks, and lined inside with such material as stringybark or grass and green branchlets. Usually the structure is exceedingly bulky, but somewhat flat on the top; a fair-sized nest measuring about five or six feet across. Situation, always a commanding one—a tall forest tree, or the forked limb of a tree at the bend of a river, or on a good mountain outlook. On the plains of the interior, where timber is absent, the nest is sometimes constructed of grass and placed on a bush.

Eggs.—Clutch, 2 usually, but sometimes 1 only; round in shape or round ovals; texture of shell coarse, surface dull and lustreless; colour warmish white, blotched and spotted with rusty red intermingled with dull cloudy purplish markings which underlie the surface of the shell. In another pair the dull purplish markings predominate, one example having the whole of the smaller end covered with a large patch of dull or light purple. In a third clutch the dull markings predominate in one egg, while the other is so richly marbled or mottled with the rusty red (in large patches in places) and purplish markings as to obliterate nearly the entire white surface. In some rare instances specimens have been known to be devoid of any markings.

Dimensions in centimetres of proper clutches, namely:—

Two taken in Victoria ...	A	(1) 7·4 x 5·7; (2) 7·2 x 5·65.
	B	(1) 7·4 x 6·15; (2) 7·3 x 6·0.
One taken in Tasmania		(1) 7·6 x 6·1; (2) 7·3 x 5·75.
One taken in Western Australia ...		(1) 6·9 x 5·75; (2) 6·68 x 5·7.

The Wedge-tailed Eagle, or, as it is commonly called, the Eagle-hawk, is truly a most noble bird, and enjoys a wide range throughout the length and breadth of Australia and Tasmania. It is, however, becoming rare in parts, and in the near future may be as scarce as the golden eagle in Europe, consequent upon the war waged against the bird by squatters and others for sundry pastoral depredations which the splendid bird by nature is tempted to commit. If we only reflect for a moment we shall learn that the good the eagles perform considerably overbalances the harm done.

Most of my experiences amongst eagles' nests have been with the Messrs. Brittlebank in that romantic locality known as the Werribee Gorge, and the adjacent ironbark forest ranges beyond Bacchus Marsh, Victoria. Since the gold era these wild localities have remained practically undisturbed for years. In some of the more secluded gullies we have seen trees supporting two or three nests, while at one favourite bend no less than six bulky structures were in sight, showing how long the birds had retained the same spot. Of course only one or two would be the new nests; the others were abandoned aeries. Sometimes we proved that a particular nest was added to and used again season after season, and contained a plentiful amount of fur, evidently from rabbits and other animals consumed by the birds and young. A favourite situation for a nest or aerie is about 30 feet from the ground in a tree on the face of a steep hill, with the gully 200 feet below and a commanding outlook on either side. Eagles' eggs in the locality mentioned have been taken as early as the end of August, and as late as 26th October. However, in other localities, notably in Queensland, eggs have been taken as early as the 10th June.

In some instances the eggs were covered with branchlets or nest *débris*, showing the birds' caution in not leaving their eggs exposed when the owners are absent. The nests, Gould had opportunities of observing, were placed on the most inaccessible trees. Although during the months of August and September he repeatedly shot birds from their aeries in which there were eggs, he was unable to obtain them, no one but the aboriginals being capable of ascending such trees. But during the year 1864 Gould received his first fine egg from Mr. George French Angas, of South Australia. Dr. Ramsay, writing to the *Ibis*, 1863, says—"The first eggs I obtained were taken in August, 1860, and were given to me by Mr. James Ramsay, at Cardington, a station on the Bell River, near Molong. They were taken from a nest by a blackboy who had 'stepped' the tree. The nest was placed upon a fork near the end of one of the main branches of a large eucalyptus. It was fully 70 feet from the ground, and no easy task to get to it. The structure was about 3½ feet high by 4 or 5 broad, and about 18 inches deep, lined with tufts of grass and with down plucked from the breasts of the birds, upon which the eggs were placed."

The following are valuable notes received from correspondents with reference to the nesting of the Wedge-tailed Eagle:—

Mr. Hermann Lau (South Queensland) states: "The eggs are two in number. A cartload of various dry sticks from the thickness of one's arm and downwards, lined inside with animal hair and grass, constitutes the nest. The eagle builds early in June, carrying the material in its talons. Situation, sometimes 50 feet from the ground in a thick fork of a large tree. Once I sent my blackfellow up to secure eggs, when the eagle swooped down on him, took his felt hat from his head, and with it soared nearly out of sight into the sky. After a while the hat fell to the ground none the worse. The eggs were secured."

Mr. James G. McDougall (South Australia) writes: "The eagle breeds in the mallee and she-oak (*Casuarina*) scrub of the uninhabited south-west portion, where I have seen their nests and eggs. The nest is made of thick sticks piled together in a slovenly fashion till the entire structure would form a good load for a cart."

From Mr. Tom Carter (North-west Australia) we learn: "The Wedge-tailed Eagles' nests I have seen on the Gascoyne coast were on bushes about five feet high, there being no trees near the coast. Two eggs were taken 2nd June." The young in down are of snowy whiteness. A nest examined by a local oologist in Tasmania contained, besides a pair of pure white eaglets, two rabbits, one opossum, and a lamb, all much decomposed. The following newspaper clipping is a fitting couplet to the foregoing:—"Mr. Percy Thomas, boundary rider for Mr. J. K. Phillips, of Rifle Downs, Victoria, felled a tree in which was an eagle's nest. When examined, the nest was found to contain two eaglets; also two kangaroo rats, two opossums, and seven rabbits, all slightly pecked."

An observing friend on the Paroo, New South Wales, noticed an eagle's nest that had been used for nine successive seasons, but whether it was occupied by the same pair of birds could not be ascertained.

To conclude our nesting observations on the Wedge-tailed Eagle I may mention that collectors not unfrequently find underneath and adjoining these large nests a nest of the yellow-rumped tomtit

(*Geobasileus chryssorhœa*), or of the spotted-sided finch (*Staganopleura guttata*), or perchance, if in the interior, of the white-face (*Xerophila*). Extremes meet, and the great stick-built aerie of the eagle seems to be an especial refuge in certain cases for the homes of the before-mentioned tiny birds. It would be merely speculation to state why the little creatures choose such places when more favourable situations are apparently available.

Nisaetus morphnoides, Gould.

(Little Eagle.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 2.

Previous Descriptions of Eggs.—"Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 12 (1865); Ramsay: P.L.S., N.S.W., vol. vii., p. 413 (1882.)

Geographical Distribution.—Australia in general, except Victoria, and New Guinea.

Nest.—When constructed by the birds themselves it is somewhat large, and is composed of sticks and twigs, lined inside with leaves, and situated in a large tree; but sometimes the eagle takes possession of a deserted crow's (or other) large nest.

Eggs.—Clutch, 1-2, more frequently 1; round ovals in shape; shell somewhat coarse or porous, surface lustreless; colour dull bluish-white, sparingly marked with blotches and dashes of light reddish-brown. In some examples the markings are absent or nearly so. Eggs from the same nest frequently vary, one being marked, the other not. Dimensions in centimetres of odd examples: (1) 5·5 x 4·5; (2) 5·62 x 4·5.

Observations.—The Little Eagle is more an interior bird, and not so commonly seen as the Wedge-tailed Eagle.

Gould discovered this fine species in 1839 at Yarrundi, on the Hunter River, New South Wales. He was led to the discovery by finding a nest of the bird, containing a single egg, which was far incubated. He regretted that, although he visited the place after killing the bird, all attempts to procure its mate were (fortunately for the mate) entirely unsuccessful. The nest, Gould states, was of a large size, and was placed close to the bole, about one-fourth of the height from the top of one of the highest gum trees. The second specimen of the egg of this species received by Gould was presented to him by the late Mr. S. White, of Adelaide, who obtained it in the interior of South Australia. The eggs of the same species, subsequently described by Dr. Ramsay, were from Mr. Bennett's collection; while the examples of these rare eggs in my own collection were taken by the Messrs. Barnard, of Coomooboolaroo, Queensland, where it has been observed that the principal breeding months for the little eagle are September and October.

Haliaetus leucogaster, Gmelin.

(White-bellied Sea-Eagle.)

Figure.—Gould: "Birds of Australia," fol., vol i., pl. 3.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 15 (1865); Hume: Nests and Eggs Indian Birds (1875), also vol. iii., p. 161 (1890); Legge: Proc. Roy. Soc. Tasmania, p. 129 (1888); North: Catalogue Nests and Eggs Australian Birds, p. 7 (1889).

Geographical Distribution.—Australia and Tasmania; also New Guinea, Malay Archipelago, Western Polynesia, India, and Ceylon.

Nest.—A very large flat structure of sticks and other *débris*, and situated on an isolated rock or cliff, but sometimes placed in a large tree—*Eucalyptus*, *Banksia*, &c.—adjacent to the coast, or inland.

Eggs.—Clutch, 2; long ovals in shape, slightly tapering at one end; texture of shell coarse, and more granulated than those belonging to the Wedge-tailed Eagle (*Uroaetus audax*); colour usually a dull white, but sometimes stained with brownish markings, probably received in the nest during incubation. When held up to the light, the interior of the shell when empty appears a dark or blackish green. Dimensions in centimetres of two clutches from islands in Bass Straits:

A (1) 7·1 x 5·35; (2) 7·2 x 5·23 (taken near Swan Island, 1884);
B (1) 7·3 x 5·55; (2) 7·1 x 5·5 (taken Kent Group, 16-9-92).

Observations.—The White-bellied Sea-Eagle is really a noble creature. Although found in secluded and retired parts round about the coast of Australia and Tasmania, this splendid bird is fast disappearing from its once favoured haunts. This is much to be regretted, if only for its interesting and ornamental appearance. Why, then, do persons so ruthlessly destroy it? Beyond taking a fat duck now and again from the property of dwellers on the coast, or "sneaking" a bird that falls wounded by a sportsman's gun, the Sea-Eagle is perfectly harmless.

With regard to the nidification of the White-bellied Sea-Eagle, Gould states:—"I could not fail to remark how readily the birds accommodate themselves to the different circumstances in which they are placed; for, while on the mountains they invariably construct their large, flat nest on a fork of the most lofty trees, on the islands, where not a tree is to be found, it is placed on the surface of a large stone, the material of which it is formed being twigs and branches of Barilla, a low shrub which is there plentiful. While traversing the woods in Recherche Bay (Tasmania) I observed a nest of this species near the top of a noble stringybark-tree (*Eucalyptus*), the bole of which measured 41 feet round, and was certainly upwards of 200 feet high. This had probably been the site of a nest for many years."

In the days of Cook and Flinders an opinion was expressed that the enormous nests observed by these illustrious navigators had been constructed by some species of *Dinornis*. Gould had no doubt that they were the nests of the Sea-Eagle. Some may have been the osprey's, which usually rears its huge stick-built aerie on some headland or islet.

According to Flinders' account, two nests of extraordinary magnitude were found near Point Possession. They were built upon the ground, from which they rose about 2 feet, and were of vast circumference and great interior capacity, the branches of trees and other matter comprising each nest being enough to fill a small cart. Captain Cook also found one of these enormous nests on an island on the east coast, which he called Eagle Island.

For many years there existed an aerie of the Sea-Eagle on Cape Wollomai, Phillip Island, Victoria. It was visited by a party of field naturalists in November, 1886, when it was found to contain a pair of fully-fledged eaglets. The following year the Field Naturalists' expedition to King Island, Bass Straits, observed several nests of the Sea-Eagle on dead blue gum-trees (*Eucalyptus globulus*) on that island.

Near Coomooboolaroo, Queensland, the White-bellied Sea-Eagle lays in June; while Mr. K. Broadbent found on the Cardwell beach, also in June, a nest containing young, built in a tea-tree (*Melaleuca*). From the other side of the continent Mr. Tom Carter writes me:—"White-bellied Sea-Eagles plentiful. Had my eye on two nests which the birds were repairing in May, but they either left the nests in consequence of sheep feeding around, or the natives got the eggs." Another season, on the 5th October, Mr. Carter observed two nests on the Lower Murchison containing incubated eggs.

Although essentially a coastal bird, the Sea-Eagle has been known to breed far inland in localities favourable to the bird's habit. Mr. Harry Barnard has taken the eggs 150 miles from the seaboard. I am aware of other instances of nests seen inland, notably on the Lower Edwards River and at Lake Moira, Riverina, New South Wales. McKinlay, the explorer, in 1862, noted the birds inland on the Upper Burdekin, North Queensland.

The breeding months of the Sea-Eagle may be said to extend from May to November, the principal laying times being June and July in New South Wales, Queensland, and other northern parts, and August and September on the southern coast, including Tasmania.

HALIASTUR INDUS (sub-species) GIRRENERA, Vieillot.

(White-headed Sea-Eagle.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 4.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 18 (1865); Ramsay: "Ibis," vol. i., p. 83 (1865); Ramsay: P.Z.S., p. 578 (1875.)

Geographical Distribution.—North-west Australia, Northern Territory, Queensland, and New South Wales; also New Guinea, Amboina, Batchian, Morty Islands, Celebes, and Louisiade Archipelago.

Nest.—About 61 cm. (2 feet) in diameter, constructed of sticks and twigs, lined with finer material or coarse grass, &c., and usually situated in a large tree in a retired locality near the coast.

Eggs.—Clutch, 2; roundish in shape; surface somewhat coarse and lustrous; colour dirty or bluish-white; marked somewhat sparingly with hair-like streaks and minute dots of reddish-brown, the markings being more numerous sometimes at the larger end, other times at the smaller. Dimensions: 5·5 x 4·25 cm. A specimen in Mr. G. A. Keartland's collection taken near Rockhampton has many light-chesnut markings about the smaller end, and measures 5·53 x 4·29 cm.

Observations.—This handsome fishing eagle in snow-white and rich chestnut plumage is tolerably common along the coastal regions of tropical Australia, and as a sub-species of *H. indus* was happily designated *girrenera* by Vieillot, *girrenera* being an Australian aboriginal name for the bird.

"This species," says Gilbert in his notes to Gould, from the Port Darwin district, "breeds from the beginning of July to the end of August. I succeeded in finding two nests, each of which contained two eggs; but I am told that three are sometimes found. The nest is formed of sticks, with fine twigs or coarse grass as a lining; it is about two feet in diameter, and built in a strong fork of the dead part of a tree. Both of those I found were about 30 feet from the ground, and about 200 yards from the beach."

Writing to the *Ibis* and giving interesting facts of the nidification of this species from Mr. Rainbird, Dr. Ramsay says:—"The nest of the Red-backed Fish Eagle is by no means so bulky a structure as that of its allies, nor is it so large as one would expect from a member of the family to which it belongs. In almost every instance the examples found by Mr. Rainbird were placed near the tops of the larger trees in belts of mangroves skirting the edges of salt-water swamps and marshes in the neighbourhood of Port Denison, Queensland. They were composed of twigs and dead branches of mangroves lined with finer material. One, from which that gentleman shot the bird and brought me the egg upon which she was sitting, was lined with tufts of lichen, and in this instance the egg was placed on various fish-bones, shells, and claws of crabs, &c. The edges and sides were beautifully ornamented with long streamers of bleached seaweed, which gave the nest a novel and pleasing appearance."

HALIASTUR SPHENURUS, Vieillot.

(Whistling Eagle.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 5.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 21 (1865); Ramsay: P.L.S., N.S.W., 2nd ser., vol. i., p. 1141 (1886); North: Catalogue Nest and Eggs Australian Birds, p. 9 (1889).

Geographical Distribution.—Australia; also New Guinea, New Caledonia, and Lord Howe Island.

Nest.—Constructed of sticks, fibrous roots, &c.; is more frequently built on the topmost forked branches of a lofty tree, but sometimes is placed amongst herbage upon the ground after the manner of the Harrier or Swamp-hawk (*Circus Gouldi*).

Eggs.—Clutch, 2; round ovals in shape; surface somewhat coarse and lustreless; colour bluish-white, fairly marked all over with blotches, spots, and other irregular-shaped markings of dark reddish-brown. In some instances the markings are more dappled or cloud-like in appearance, and of a lighter shade of brown intermingled with others of purplish-red. Differences in character of colouration may occur in the same nest. Dimensions in centimetres of a clutch taken at Coomooboolaroo, Queensland, 16th October, 1885: (1) 5·3 x 4·25; (2) 5·26 x 4·15.

Observations.—This splendid hawk is a common species in nearly every part of Australia; and as its more handsome fishing cousin, *H. girrenera*, loves the coastal region, so the Whistling Eagle prefers the more inland dominions.

Gould, who first described the eggs, once found a nest of this species in the side of which had been constructed that of the beautiful Spotted-sided Finch (*Staganopleura guttata*). Both birds were sitting on their respective eggs close beside each other; "and both," adds Gould, "would doubtless have reared their progenies had I not robbed the nests of their contents to enrich my collection."

I was present at the taking of the eggs of the Whistling Eagle in my collection; Mr. Harry Barnard, of Coomooboolaroo, being the climbing performer. The tree was by the lagoon near the homestead, and the nest by actual tape measurement was 85 feet from the ground. For about half the distance steps had to be chopped in the smooth barrel with a tomahawk in order to reach the first forked limb. While Mr. Harry was climbing, the bird scuttled off her nest and flew directly away. Eggs were previously taken from the same nest, and again subsequent to my visit, which was 16th October, 1885; therefore it is proved that the Whistling Eagle, like many of the other hawks, reoccupies its old home. That the Whistling Eagle is sometimes an autumn breeder (according to the season) has also been proved, for the Messrs. Barnard, during the beginning of April, 1883, took a pair of that bird's eggs from a nest.

Mr. George H. Morton, an astute field observer, took a pair of Whistling Eagle's eggs from a nest in long grass on his farm near the river Murray.

Mr. Charles C. Brittlebank informs me he has taken the Whistling Eagle's eggs from the usual nest in a tree as early as the 25th August (1893), near Myrniong, Victoria. Therefore the breeding months of this species may be said to extend from August to December, and the bird occasionally lays in the autumn in Queensland.

Milvus affinis, Gould.

(Allied Kite.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 21.

Previous Descriptions of Eggs.—Ramsay: P. L. S., N.S.W., vol. vii., p. 413 (1882); North: Catalogue Nests and Eggs Australian Birds, app. (1890); Hume: Nests and Eggs Indian Birds, vol. iii., p. 176 (1890).

Geographical Distribution.—Australia; also New Guinea and Malayan Archipelago, ranging as far north as India and China.

Nest.—A somewhat rough structure composed of sticks, lined inside with pieces of sheepskin with wool attached or other substitutes, and situated in a tree or on a bush. Sometimes a deserted nest of another bird of prey is used.

Eggs.—Clutch, 3-4; round ovals in shape; surface somewhat fine but lustreless; colour dull white, sparingly marked with spots and blotches of reddish-brown; inside lining of the shell greenish. A clutch from the Adelaide Museum, in Mr. Dudley Le Souëf's collection, measures in centimetres: (example sparsely marked on smaller end) 5·15 x 3·86; (example faintly marked on top) 5·25 x 4·0; (example lightly smudged about the lower half) 5·46 x 3·98.

Observations.—I considered the eggs Dr. Ramsay first described as altogether too small for so large a bird; while the eggs I described, I have reason to believe now, were not laid by an Allied Kite at all. However, Mr. North, who has had an opportunity of examining many specimens that pass from time to time through the Australian Museum, says there is a great variation in their size, shape, and colour and disposition of their markings.

The late Mr. K. H. Bennett, of Yandembah, New South Wales, communicated exceedingly interesting notes relating to the nidification of the Allied Kite, which appear in the appendix of Mr. North's catalogue. From one place I quote:—"The nest is a rough structure very similar to that of *Circus assimilis* (Jard. and Selby), composed outwardly of sticks, and, in the four I have examined, lined with small pieces of sheepskins with the wool on, picked from carcasses of dead sheep scattered over the plains. The nests are placed as a rule on the tops of pine-trees (*Callitris*) where the topmost branches divide, forming a three or more pronged fork or division, which securely holds the rough structure in position. In two instances this year (1889) the disused nests of *Hieracidea orientalis* were taken possession (from one of which in October last I took the *Hieracidea's* eggs), the only additions being the sheepskin lining. The number of eggs for a sitting never, so far as my experience goes, exceeds two."

The earliest nest containing eggs found by Mr. Bennett was on the 8th October, the latest on the 20th December; while we learn from Mr. Price Fletcher that from Christmastide to the end of February is the chief nesting time for this Kite in the far interior of Queensland.

Lophoictinia isura, Gould.

(Square-tailed Kite.)

Figure.—Gould: "Birds of Australia," fol., vol. i, pl. 22.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 51 (1865); Ramsay: P.L.S., N.S.W., vol. vii., p. 413 (1882); North: Catalogue Nests and Eggs Australian Birds, p. 11 (1889).

Geographical Distribution.—Queensland, New South Wales, Victoria, South and West Australia.

Nest.—Constructed of sticks and twigs, lined sparingly with eucalpyt leaves and fibrous bark, and placed usually in the higher forked branches of a lofty tree.

Eggs.—Clutch, 2-3; roundish or round ovals in shape; surface slightly coarse and lustreless; colour soft, warm, or buffy white. Examples in same clutch frequently vary much in character and colour of the markings. One of a pair is richly marked around the upper quarter with blotches and smudges, mostly confluent, of dark reddish-brown, the other being lightly clouded all over (except on either end, which is more spotted) with pinkish or chestnut-red; inside lining of the shell yellowish-green. Dimensions, in centimetres: (1) 5·25 x 3·9; (2) 5·1 x 4·0.

Observations.—The two first recorded nests of the Square-tailed Kite were discovered almost simultaneously in November, 1839—one by Gould himself on the Upper Hunter River, New South Wales; and the other by his able coadjutor, Gilbert, at the opposite side of the continent, in Western Australia. In Gould's nest were a pair of eggs, while Gilbert's contained two young ones scarcely feathered. This nest was the usual structure of sticks placed on a horizontal branch of a white gum-tree in a dense forest.

Six-and-forty years after these illustrious naturalists I find myself wistfully gazing at a hawk's nest, about 70 feet above me, in a slanting forked branch of a gum-tree. Yes; and the bird is sitting.

A stick thrown half-way up rustles amongst the branches, and away soars a Kite, its square-fashioned tail leaving no doubt as to its identity. Fortunately I am accompanied by Mr. Harry Barnard, and in almost less time than it takes to write these sentences he has climbed the tree, and descends with a pair of the most handsomely marked of hawk's eggs. They are now in my cabinet with date, "Coomooboolaroo, 10-10-85." I shall never forget that week, for we took no less than five different species of hawks' nests, each with a pair of beautiful fresh eggs. They were—Whistling Eagle, Australian Goshawk, Little Falcon, Brown Hawk, and Square-tailed Kite.

All these birds—indeed, the majority of the hawk tribe—will lay again in the same nest if robbed, or use again the previous season's nest, or even exchange nests, as the following Coomooboolaroo note proves:—"Hawk's nest appropriated as follows: First by a Square-tailed Kite, then by a Brown Hawk, succeeded by a Sparrow-hawk."

The last three months of the year are probably the principal breeding time of the Square-tailed Kite.

ELANUS AXILLARIS, Latham.

(Black-shouldered Kite.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 23.

Previous Descriptions of Eggs.—Ramsay: P.L.S., N.S.W., vol. ii., p. 109 (1878); North: Catalogue Nests and Eggs Australian Birds, p. 14 (1889).

Geographical Distribution.—Whole of Australia.

Nest.—Comparatively bulky, constructed of sticks and twigs, and usually situated in the forked branches of a tall tree.

Eggs.—Clutch, 3-4. "The ground colour, where visible, is a dull white, but it is mostly obscured by blotches and smears of a dark reddish-chocolate. Length (*A*) 1·6 x 1·25 inches (4·06 x 3·17 cm.); (*B*) 1·72 x 1·25 inches (4·36 x 3·17 cm.); (*C*) 1·58 x 1·27 inches (4·01 x 3·22 cm.). One specimen (*A*) is reddish, rusty, chocolate-smeared, and clouded with a darker tinge."—*Ramsay.*

Observations.—As Gould states, although this beautiful Kite ranges over the Australian continent, the bird is only thinly dispersed. The last specimens I happened to observe in Victoria were a beautiful pair which were hawking over the rich alluvial flats of Bacchus Marsh, 28th March, 1889.

I have used Dr. Ramsay's description for these rare eggs. He further adds: "During the last six years several pairs of these hawks have been known to breed on the Jindah Estate, on the Mary River, in Queensland, but it was only in November last (1877) that a pair gave my brother (Mr. John Ramsay) an opportunity of taking their nest and eggs. The nest in question was placed among the topmost forked branches of a *Flindersia*, and, as usual, composed of sticks and twigs; it was, however, a bulky structure, as is often the case with Australian hawks' nests. The eggs were three in number, but my brother assures me that four is the correct number for a sitting."

While under the Liverpool Range, Gould shot a young Black-shouldered Kite which had not long left the nest. He therefore conjectured that the bird bred within the colony of New South

Wales. The conjecture has since proved correct, for Mr. North has described, from Dr. Cox's collection, a very handsome set of eggs of the species which were taken near the Hawkesbury River.

ELANUS SCRIPTUS, Gould.

(Letter-winged Kite.)

Figure.—Gould: "Birds of Australia," fol., vol i., pl. 24.

Previous Descriptions of Eggs.—Gould: "Birds of Australia," Handbook, p. 55 (1865); North: Catalogue Nests and Eggs Australian Birds, p. 15 (1889).

Geographical Distribution.—South Queensland, New South Wales, Victoria, South and (probably) West Australia.

Nest.—Constructed of sticks, lined with rubbish (chiefly pellets composed of rat's fur ejected from the stomach of the birds), and situated in a tree. According to Gould, in some localities the nests are placed as near each other as possible, in companies.

Eggs.—Clutch, 4; ovals in shape; surface of the shell somewhat fine, with least perceptible trace of lustre or gloss; ground colour, where visible, buffy-white, heavily mottled and blotched all over with dirty or dull reddish-brown. Inside lining of the shell yellowish-green. Dimensions, in centimetres: (1) 4·55 x 3·4; (2) 4·43 x 3·37. Gould, on the authority of the late Mr. S. White, states the markings are easily removed by wetting.

Observations.—The Letter-winged Kite does not enjoy such an extensive range as the preceding species, being more limited to interior provinces.

GYPOICTINIA MELANOSTERNON, Gould.

(Black-breasted Buzzard.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 20.

Previous Descriptions of Eggs.—Bennett: P.L.S., N.S.W., vol. vi., p. 146 (1881); Ramsay: P.L.S., N.S.W., vol. vii., p. 413 (1882); Campbell: "Southern Science Record" (1883); North: Catalogue Nests and Eggs Australian Birds, p. 13 (1889).

Geographical Distribution.—Interior provinces of Australia in general.

Nest.—Large, resembling a Wedge-tailed Eagle's (*Uroaetus audax*) aerie; roughly constructed of sticks, and generally situated in the thick fork of a tree.

Eggs.—Clutch, 2; round in shape; surface somewhat coarse and lustreless; colour dull white; (1) has a few indistinct large brown blotches about the centre of the egg, and is covered all over with dark-violet hieroglyphics; (2) is blotched all round the centre and about the larger end with dark-brown, inclining to violet, intermingled with a few indistinct lilac blotches. Dimensions: 6·35 x 4·5 to 4·9 cm.

The descriptions are from a pair of eggs taken by Mr. H. H. Peck, in the Riverina district, on the 17th September, 1883.

Observations.—This exceedingly fine bird of prey is not a common species, and appears to be confined to the plains of the interior, especially those bordering rivers.

Gould did not succeed in procuring the eggs of the Black-breasted Buzzard, leaving Mr. Bennett, Dr. Ramsay, and myself to make a rush for places long years afterwards. I think we finished in the order named, with this disadvantage to myself—that the eggs I described did not become my property.

The only nest of the Buzzard I have observed was near Moulamein, Riverina. It was slightly smaller than the eagle's aerie, was situated in the fork of a dead tree, at no great height above ground; but the tree, being barkless and "greasy," was difficult to climb; therefore the inside of the nest was not inspected. The Buzzard was observed in the vicinity, but did not appear to be sitting. When we retired to a distance, crows came and wrangled with each other at the side of the nest, most probably over some flesh that the old Buzzard had left for its young. It was then the 18th September.

The chief breeding months of the Buzzard may include from August to November.

"The natives, Mr. Drummond and his son, Mr. Johnson Drummond, tell me," says Gilbert, "that this bird is so bold that, upon discovering an emu sitting on her eggs, it will attack her with great ferocity until it succeeds in driving her from the nest, when, the eggs being the attraction, it takes up a stone with its feet, and while hovering over the nest lets it fall upon and crush them, and then descends and devours their contents." Gould adds: "It is to be wished that persons favourably situated would ascertain if the story of the birds breaking the eggs of the emu be correct, or if it be one of the numerous myths of the aborigines." However, the aborigines are correct for once, and the fact has been fully established by the late Mr. K. H. Bennett, who enjoyed singular opportunities for observing the Buzzard in the interior country of New South Wales. I quote at length from Mr. Bennett, in the "Proceedings of the Linnean Society of New South Wales":—

"Its prey to a great extent consists of various reptiles—such as snakes, frill-necked and sleepy lizards; it also has the singular habit of robbing the nests of emus and bustards of their eggs. My first information on this point I obtained from the blacks,* and for some time I was inclined to disbelieve their assertion, though the same story was told by the blacks from all parts of the district, as it was so contrary to my experience of the Accipiter family. At length, however, I was compelled to alter my opinion, for I subsequently found portions of emu egg shells in the nest of one of these Buzzards. The manner in which they effect the abstraction of the emu eggs—as told me by the blacks—shows an amount of cunning and sagacity that one would scarcely give the bird credit for, and is as follows:—On observing a nest, the Buzzard searches for a stone, or what is much more frequently found here, a hard lump of calcined earth. Armed with this, the Buzzard returns, and, should the emu be on the nest, alights on the ground some distance off, and approaches with outstretched flapping wings. The emu, alarmed at this, to it, strange-looking object, hastily abandons the nest and runs away. The Buzzard then takes quiet possession, and with a stone breaks a hole in the side of each egg, into which it

* Mr. Bennett has probably inadvertently overlooked the fact that a blacks' story is likewise mentioned in Gould.

inserts its claw and carries them off at its leisure, for when the eggs are broken the emu abandons the nest. So much for the blacks' story.

"This, however, is in a great measure corroborated by a friend of mine who lives on the adjoining station, and who told me that in August last (1881) he found the nest of an emu containing five eggs, and all of them had a broken hole in the side, and that the fracture had been done quite recently, and in the nest also was one of these lumps of calcined earth about the size of a man's fist.

"In a nest to which I recently ascended, I found amongst the remains of various reptiles the shells of a couple of bustard's eggs. In the nest were a couple of young Buzzards lately hatched."

With regard to the nidification of the Black-breasted Buzzard, Mr. Bennett proceeds to state—"It usually lays about the middle of August, and the young leave the nest about the beginning of December. If undisturbed the old birds resort year after year to the same nest, but should it be robbed they abandon it for ever, and it is never occupied by the same species again, although other species of hawks, notably the brown hawk, sometimes take possession. I have never known a Buzzard to touch carrion or feed upon anything it did not capture, and except at the nest I have never seen them perch on a tree, but have often seen them perch upon the ground. The note, which is something between a whistle and a scream, is only uttered when visiting the nest."

Baza subcristata, Gould.

(Crested Hawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 25.

Previous Descriptions of Eggs.—Gould: "Birds of Australia," Handbook, vol. i., p. 57 (1865); Ramsay: P.Z.S., p. 392 (1867).

Geographical Distribution.—Northern Territory, Queensland, New South Wales, and interior of South Australia (?).

Nest.—The usual stick structure built by hawks, and situated in a tree.

Eggs.—Clutch, 3-4; roundish in shape, but sometimes inclined to be pointed at one end; surface of the shell comparatively fine; in other examples rough and granulated, with a slight trace of lustre; colour usually uniform bluish-white, but in some instances very meagrely blotched and spotted with light-brown. Dimensions, in centimetres, of odd eggs: 4·33 x 3·63 (round example); 4·45 x 3·55 (pointed example).

Observations.—For the eggs of this fine and singular Hawk I am indebted to the late George Barnard, of Coomooboolaroo, from whom I received them in 1883. They tallied with the description of the single egg furnished by Gould. However, Dr. Ramsay redescribed other eggs of the Crested Hawk, in 1867, with the following information:—"I was fortunate enough to procure three eggs of this species taken by Mr. Macgillivray's blackfellow 'Daddy.' Mr. Macgillivray informs me that when 'Daddy' was taking the eggs the female dashed so close to him that he killed it with his tomahawk. The male bird belonging to the nest had been shot the day before. The nest was a comparatively small structure of sticks, and placed upon a horizontal bough, at a considerable distance from the ground.

The eggs have the peculiarity of being very much rounded at the larger end, are short upon the whole, and have the thin end pointed abruptly."

FALCO MELANOGENYS, Gould.

(Black-cheeked Falcon.)

Figure.—Gould: "Birds of Australia," fol., vol. ii., pl. 8.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 27 (1865); North: Catalogue Nests and Eggs Australian Birds, p. 16 (1889); North: Records Australian Museum, vol. ii. (1892).

Geographical Distribution.—Australia in general, and Tasmania; also Moluccas and Java.

Nest.—Usually a crevice or ledge on an inaccessible cliff on the sea-coast but sometimes on perpendicular rocks inland, or a hollow spout of a tree, or even a deserted stick-nest of a larger bird is appropriated. Instances have been known of a covert of tussock-grass being chosen on the plains.

Eggs.—Clutch, 3; round ovals in shape, slightly compressed towards one end; texture of shell somewhat fine; surface lustreless; ground colour buff, which is scarcely perceptible, being obscured by the freckles and other small markings of pinkish-red, in some examples with chestnut-red. Upon these markings, again, sparingly distributed, are larger markings or blotches of dark red or brown. Pinkish-red specimens may appear in the same set with a chestnut-red one. As in all falcons' eggs, the inside lining of the shell, when held up to transmitted light, is a buffy colour. Dimensions of a proper clutch, in centimetres: (1) 5·23 x 4·05; (2) 5·14 x 4·05; (3) 5·16 x 3·98.

This description is taken from a very beautiful clutch presented to me by my young friend, Mr. Charles French, junr. Its history is mentioned further on.

Observations.—This fine, bold, and dashing Falcon is a widely distributed species frequenting, in pairs, wild rocky regions of the coast or cliffy localities inland suitable to its nature.

In writing to me in 1886, Mr. E. D. Atkinson mentions he found in an almost inaccessible position three eggs of this Falcon, far incubated, on the top of a cliff (not on the face) on an island off the north-west coast of Tasmania. The date was 8th of October.

In the Australian Museum Catalogue, and quoting valuable correspondents, Mr. North furnishes some extremely interesting notes regarding the nesting of the splendid Black-cheeked Falcon:—"On the 4th October, 1888," writes Dr. L. Holden, of Circular Head, Tasmania, "I found a nesting-place of the Black-cheeked Falcon on the cliffs that bound Sisters' Beach on the south-east; it was the same place that Mr. Atkinson obtained his nest on the 10th September, 1887. The eggs were three in number and hard set, but could be blown, and laid on the rock without any nest, the ledge being but 10 or 12 feet from the base of the cliff, and quite easily reached by a zigzag approach scarcely to be called a climb, the projecting rocks forming an easy stairway." Again, "I took a clutch of Falcon's eggs last Saturday, the 26th September, 1891, from the same spot to an inch which I robbed in 1888. It is not a bare rock where the eggs were found; there is a covering of grit and *detritus*."

Mr. North also states that "the late Mr. K. H. Bennett found a nest of this species at Mount Manara, in the Wilcannia district, New South Wales, on the 9th September, 1885, which contained three eggs. The nest was about 70 feet from the ground, and very difficult to obtain, being placed upon the face of an almost perpendicular rock. Upon visiting the same place the following year in the month of October, Mr. Bennett found that the same pair of birds had repaired the old nest, and that it contained a single fresh egg; but when disturbed again by his climbing to it they abandoned it, and built a new nest a few yards higher up out of reach, the rock on which it was placed completely overhanging the site of the old nest."

This Falcon appears very local in its habit. On Cape Wollomai, Western Port, a pair of birds could always be found, but we could never find the nesting-place, which was no doubt on the face of that bold headland. During the visit of the Field Naturalists' expedition to Kent Group, Bass Straits, November, 1890, two young Falcons in down were observed on a precipitous rocky ledge where were the remains of Prions, &c., on the isolated North-east Isle. The old birds were furious, and one even struck our leader (Mr. D. Le Souëf) in the rear as he was crawling along the projecting rocks.

From Mr. Davis, who was attached to a railway survey camp in the Wimmera district, Victoria, I gather the following information:—He found the eggs of the Black-cheeked Falcon in the hollow of a dry tree close to Lake Hindmarsh. When hatched, he sent the young birds to Mr. Charles French, Government Entomologist. Mr. French thoughtfully brought them under my notice. Again, on the 18th August, 1889, Mr. Davis took fresh eggs of the Falcon, this time from a wedge-tailed eagle's nest, which was situated in a red gum-tree near a swamp called Brambrook, about twenty miles west from Lake Albucutya. When climbing the tree one of the birds attacked Mr. Davis, and would have struck him had he not waved his hat in a frantic manner. But when the nest was actually reached it was a pretty sight to witness the male bird perched on the opposite side of the great nest and daringly, and I may say nobly, with uplifted wings disputing the removal of the eggs, notwithstanding by robbery the Falcon itself had annexed the eagle's nest. These eggs ultimately found their way into my collection, and are certainly unique, if only for their interesting history.

The breeding months of this Falcon are from August to November.

FALCO HYPOLEUCUS, Gould.

(Grey Falcon.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 7.

Previous Descriptions of Eggs.—Ramsay: P.L.S., N.S.W., vol. vii., p. 414 (1882).

Geographical Distribution.—Northern Territory, South Queensland, New South Wales, Victoria, South and West Australia.

Nest.—Constructed of sticks and twigs, and situated in a tall tree. Probably a nest built by another large bird is used.

Eggs.—Clutch. 3 (and 4 probably). "Ovals in shape, the whole of the ground colour being obscured by minute dots and freckles of rusty red. There is in one an indistinct band on the larger end; the shell is smooth and slightly glossy. The bird was seen on the nest.

Length: (*A*) 2·07 x 1·51 inches; (5·25 x 3·83 cm.); (*B*) 2·0 x 1·52 inches; (5·08 x 3·86 cm.)"—*Ramsay*.

Observations.—Dr. Ramsay further adds:—"This is a rare species not plentiful in any part of Australia, but occasionally obtained in the northern portion of the interior of Queensland, and Mr. Gould records it from Western Australia. I am indebted to Mr. J. B. White for specimens of the eggs taken on the Upper Thomson River, in Queensland."

A pair of Grey Falcon's eggs in Mr. G. A. Keartland's collection, taken in the interior, 1894, measure, in centimetres: (1) 5·05 x 3·88; (2) 5·1 x 3·96.

FALCO SUBNIGER, Gray.

(Black Falcon.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 9.

Previous Descriptions of Eggs.—Bennett: P.L.S., N.S.W., vol. x., p. 167 (1885); Ramsay: P.L.S., N.S.W., 2nd ser., vol. i., p. 1142 (1886).

Geographical Distribution.—Northern Territory, Queensland, New South Wales, Victoria, and South Australia.

Nest.—Usually a stick-built home of another bird of prey or other large bird, and situated in a tree, or, in the far interior, sometimes placed on a bush.

Eggs.—Clutch, 4. "Closely resemble large specimens of the Merlins, and are not unlike finely freckled eggs of *Hieracidea orientalis*, but of a richer or brighter red, the ground colour being obscured with rich reddish dots and freckles all over the surface; in some these dots form confluent markings on one end of the egg, or patches on the side. They are almost identical in colour and shape with those of *F. hypoleucus*, but larger. The shell is of finer grain than is shown in those of the *Hieracideæ*. In form they are almost true ovals, being but slightly swollen at the thicker end. One is rather elongate in form. Length: (*A*) 2·1 x 1·6 inches (5·33 x 4·06 cm.); (*B*) 2·13 x 1·58 inches (5·41 x 4·01 cm.); (*C*) 2·18 x 1·55 inches (5·53 x 3·93 cm.)."—*Ramsay*.

Observations.—I have never been fortunate enough to see, in a state of nature, this bold and audacious Falcon, which has been significally called by a bush naturalist "Death on the Wing." The Black Falcon is a rare interior species.

Dr. Ramsay, in describing the eggs, states that he is enabled to do so through the exertions and liberality of the late Mr. K. H. Bennett; at the same time Dr. Ramsay refers us to Mr. Bennett's own most interesting and exhaustive account of the habits of this Falcon, the reference to which is given above.

We infer from the authorities above quoted that the breeding season usually includes September and October, and, in the far interior, December to February.

FALCO LUNULATUS, Latham.

(Little Falcon.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 10.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 30 (1865); North: Catalogue Nests and Eggs Australian Birds, p. 19 (1889).

Geographical Distribution.—Whole of Australia and Tasmania; also Flores.

Nest.—Large for the size of the bird, being usually an old stick-built home of another hawk, crow, &c., which the Falcon lines again with green branchlets of eucalypts.

Eggs.—Clutch, 2-3; inclined to ovals in shape; texture of shell fine, but lustreless; ground colour buff or buffy-white, which is nearly obscured by the freckled and mottled markings of light reddish-brown. Dimensions of a clutch, in centimetres: (1) 4·34 x 3·15; (2) 4·02 x 3·21.

Observations.—The Little or the White-fronted Falcon is the smallest and probably the most frequently seen of our Australian Falcons, being found throughout the continent, as well as Tasmania. It loves such wild rocky situations as the Werribee Gorge, Victoria, where it has been found breeding by the Messrs. Brittlebank. My experiences with this fine little fellow have been in Queensland. One afternoon, near the edge of an interesting forest, I noticed a bronze-wing pigeon and a Falcon in its wake, both flying at a tremendous rate of speed; they seemed simply to cut streaks in the air. The pigeon by reaching the timber (its only chance) thus evaded its bold adversary.

A nest I saw was not less than 50 or 60 feet from the ground, near the top of a straight tree, well-balanced with boughs, and standing at the edge of a lagoon. With the generous exertions of Mr. Harry Barnard, I was enabled to place the contents of the nest—a pair of rare eggs—in my cabinet. Mr. Barnard tells me he has never known the Little Falcon to make a nest of its own, always choosing the deserted nest of some other hawk and lining it again with green twigs.

Gould succeeded in finding several nests of the Little Falcon both in Tasmania and on the continent; they were all placed near the tops of the most lofty trees, and generally inaccessible. The nests were rather large structures, being fully equal in size to that of a crow, and slightly concave in form. In all probability they were crows' old nests.

In Tasmania Mr. A. E. Brent took the eggs of the Little Falcon from the broken spout of a peppermint-tree (eucalypt). There was no nest save a few small sticks round about the eggs, which reposed on the rotten substance in the hollow.

Hieracidea orientalis, Schlegel.

(Brown Hawk.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 11.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 32 (1865); North: Catalogue Nests and Eggs Australian Birds, p. 20 (1889).

Geographical Distribution.—Whole of Australia and Tasmania.

Nest.—Constructed of sticks and twigs, lined with leaves, strips of bark, &c., and usually situated in the forked branches of a tall tree, sometimes on bushes in the interior. Frequently another hawk's or crow's old nest is used.

Eggs.—Clutch, 2-3, sometimes 4; generally round ovals in shape, in some instances pointed or compressed towards one end; texture of shell somewhat fine, but lustreless. There is much variation in the appearance of different sets, even examples in the same nests differing. A common type has a buffy-white ground colour, speckled and blotched with reddish-brown, the markings increasing in number towards the larger end, where they form a dark confluent patch. Another pair has the ground colour almost obscured by freckles and small markings of dark reddish-brown, with a darker patch on the large end of one specimen, and one on the smaller end of the other example. Again, another type is freckled and mottled over the entire surface with light reddish-brown. Dimensions, in centimetres, namely:—Of a large pair taken in Queensland (1) 5·6 x 3·97; (2) 5·55 x 3·95; of an average pair taken in Victoria (1) 5·46 x 3·9; (2) 5·35 x 4·0; of a small pair (selected) (1) 5·25 x 3·78; (2) 5·02 x 3·7.

Observations.—The ordinary Brown Hawk may be observed anywhere in Australia and Tasmania, and no specimens are more common in collections than its rusty-brown eggs.

The eggs in my cabinet are from two nests, of which I witnessed the taking. One was found near Bagshot, Victoria, on the 4th October, 1880; the other in Queensland, 13th October, 1885. There were only a pair of eggs in each instance, which, however, were perfectly fresh, and may not have been the full complement. When one is on official leave of absence it is not always convenient to wait the development of full clutches, however desirable in the interests of knowledge. Then there is the old adage that "a bird (and I suppose an egg, for the greater includes the less) in the hand is worth two in the bush."

Mr. H. C. Burkitt, formerly of Cooper's Creek, kindly sent me a pair of Brown Hawk's eggs from a set of four which he states he took from a nest built on a needle (*Hakea*) bush.

The Brown Hawk, instead of building for itself, frequently uses the old nest of such birds as a kite or other hawk or crow. Mr. G. A. Keartland supplies the following note:—" Brown Hawk, clutch of three eggs, found in crow's nest, Werribee (Victoria), 23-9-93." It is said that the Brown Hawk will at times lay in hollow trees in the great north-western interior of Queensland.

Breeding months include August to November, the principal being September and October, and sometimes in Northern Queensland from Christmas to the end of February.

Hieracidea berigora, Vigors and Horsfield.

(Striped Brown Hawk.)

Figure.—Gould: " Birds of Australia," fol., vol. i., pl. 12.

Previous Descriptions of Eggs.—Gould: " Birds of Australia" (1848), Handbook, vol. i., p. 34 (1865); North: Catalogue Nest and Eggs Australian Birds, p. 21 (1889).

Geographical Distribution.—Queensland, New South Wales (? interior), Victoria, South, West, and North-west Australia.

Nest.—Similar to that of the ordinary Brown Hawk, constructed of sticks and twigs, lined with leaves, &c., and situated in the fork of a tree, in some cases placed on the crown of a grass-tree (*Xanthorrhœa*). A deserted crow's nest is sometimes used.

Eggs.—Clutch, 3-4 usual, rare instances 5; roundish ovals in shape; texture of shell somewhat fine; surface lustreless. As in those of *H. orientalis*, which they resemble, the ground colour is buffy-white, freckled and mottled over almost the entire surface with rich reddish-brown, usually forming a patch about the larger end, in some instances on the smaller end. In common with the eggs of the other Brown Hawk, as well as those of the falcons, the inside lining of the shell is of a buffy colour when held up to transmitted light.

A handsome clutch taken at Quindalup, on the 18th October, 1889, during my trip to Western Australia, measures, in centimetres: (1) 5·4 x 4·0; (2) 5·37 x 4·04; (3) 5·22 x 4·03.

Observations.—The Western or Striped Brown Hawk, although found in many parts of Australia, is not so common as the ordinary Brown Hawk ranging more over the vast western territory.

The two clutches of eggs kindly presented to me while in Western Australia contained each a complement of three eggs, while one was taken from a nest built on the crown of a grass-tree. Another nest I myself found was situated in a beautifully leafed eucalypt (*E. calophylla*), locally known as the red gum-tree. The bird was sitting, but the nest was inaccessible except to such expert climbers as the Messrs. Barnard.

Near Point Cloates (Western Australia) Mr. Tom Carter, one September, took the unusual number of five eggs from a nest. He has taken eggs of the Western Brown Hawk in the same district as early as the middle of July.

Breeding months from July to November.

CERCHNEIS CENCHROIDES, Vigors and Horsfield.

(Nankeen Kestrel.)

Figure.—Gould: "Birds of Australia," fol., vol i., pl. 13.

Previous Descriptions of Eggs.—Gould: "Birds of Australia," Handbook, vol. i., p. 36 (1865); North: Catalogue Nests and Eggs Australian Birds, p. 22 (1889).

Geographical Distribution.—Australia generally and Tasmania.

Nest.—A crevice in a cliff, a hollow spout of a tree, or a deserted nest of a crow. In the far north-west a hole in an ant-hillock has been used.

Eggs.—Clutch, 4-5; roundish in shape, slightly compressed at one end; texture of shell fine with a perceptible trace of lustre or gloss on the surface; ground colour buffy-white, in some instances freckled all over with reddish-brown, but more generally blotched as well with rich reddish-brown, and forming a patch upon one end of the egg, usually the larger but sometimes on the smaller. In other specimens the markings are of a rich, dark, pinkish-red. Dimensions of a full clutch, in centimetres: (1) 3·85 x 3·0; (2) 3·88 x 2·91; (3) 3·82 x 3·0; (4) 3·8 x 3·03; (5) 3·8 x 2·93.

Observations.—This beautiful little Hawk is found nearly everywhere flying over forest, but mostly plain, in Australia. It is not so plentiful in Tasmania.

I possess a lively recollection of the first Kestrel's nest I robbed. It was one 9th November. The nesting-place was simply on the dust within a crevice or crack in an overhanging red cliff of the Werribee River, near its mouth. Some trouble and risk were incurred in climbing the cliff's face. The eggs were apparently much incubated; therefore were carefully packed in the "billy," to be operated on at home. However, on the journey thither from the Werribee station, the portion of the train I entered was derailed, and I nearly lost my precious specimen and my life.

Gould once took four fully-fledged young birds from holes in a tree by the side of a lagoon in the interior of New South Wales. I have also witnessed Kestrels entering a hollow spout of a tree overhanging the Werribee River, where I had no doubt the birds were breeding. We have also Gilbert's note from Northern Australia, which he recorded when attached to Dr. Leichhardt's Expedition—"October 2. Found for the first time the egg of *Tinnunculus cenchroides*, four in number, deposited in a hollow spout of a gum-tree overhanging a creek. There was no nest, the eggs being merely deposited on a bed of decayed wood."

Gould also observed nests which he supposed were constructed by the Kestrel, but saves himself by surmising that possibly they may have been deserted domiciles of crows or crow-shrikes. The great naturalist's surmise has since proved correct.

My next adventure with Kestrels was many years after the railway "incident," with my namesake, Mr. Charles E. Campbell, among the belts of "box" timber on the plains near Pyramid Hill, Victoria. All our finds were taken from crows' old nests, and usually the full complement of five eggs. In some cases many crows' nests containing their own eggs were in the same tree with the Kestrels. The following are taken from my notes:—

4th October, 1884.—Found Kestrel's (*i.e.*, a crow's) nest with young, and one egg. Crows' nests with young also in the same tree.

6th October, 1884.—Took out of Crow's old nest 5 Kestrel's eggs.
7th " " " " 4 " "
9th " " " " 5 " "

I possess a note from South Australia by Mr. James C. McDougall, stating that the Nankeen Kestrel there nests commonly in crows' nests, laying four eggs; while on the western side of the continent Mr. Tom Carter has recorded for me—"Sept. 22: 5 Kestrel's eggs on the Minilga River." "Nov. 8 and 15: Eggs just hatching. Twenty-five miles inland from Point Cloates." Also he noted the remarkable discovery of a Kestrel's nest within an ant-hillock, which are conspicuous features in the country thereabouts and elsewhere.

Breeding months of the Kestrel may include from August to November or to December.

Pandion halitaetus (sub-species) leucocephalus, Gould.
(White-headed Osprey.)

Figure.—Gould: "Birds of Australia," fol., vol. i., pl. 6.

Previous Descriptions of Eggs.—Gould: "Birds of Australia" (1848), also Handbook, vol. i., p. 23 (1865); Ramsay: P.Z.S., p. 578 (1875); North: Catalogue Nests and Eggs Australian Birds, p. 23 (1889).

Geographical Distribution.—Australian coast in general and Tasmania; also New Guinea and Moluccas.

Nest.—A structure of great size, about 4 feet high by the same dimension in breadth, built of sticks, with a shallow cavity lined with seaweed. Usual situation an inaccessible rock or island, but low timber near water is sometimes chosen.

Eggs.—Clutch, 3-4; shapely ovals, slightly compressed towards one end; texture of shell somewhat granulated, surface of soft appearance and lustreless; ground-colour, buffy, or yellowish-white. In three examples of a splendid set taken from an aerie near the mouth of the Margaret River (W.A.), the markings are mostly large and bold blotches of rich, dark, purplish-brown, more numerous about the upper half of the egg, and forming a large confluent patch almost black on the apex; while the fourth egg is not so heavily blotched, the markings of pinkish-brown, intermingled with dull purple, being lighter and more evenly distributed over the surface; inside lining of the shell, when held up to the light, dull yellowish-green. Dimensions, in centimetres: (1) 6·3 x 4·52; (2) 6·2 x 4·58; (3) 6·15 x 4·56; (4) 6·15 x 4·42.

Observations.—My only experiences with this expert Fishing Hawk were in Western Australia. At Wallcliffe, on the Margaret River, a nest, with slightly hollowed top, was about 4 feet high, with a circumference of about 13 feet, constructed of sticks and roots, and situated about 25 feet above high-water mark. The old birds were circling on high, their white heads just distinguishable from their dusky bodies set against the azure sky, and were uttering piercing cries of solicitude for the safety of their helpless offspring below.

The exact date of the foregoing was the 5th November, 1889. Mr. Bussell compensated for my disappointment at finding only young by presenting me with a full clutch of the unusual number of four eggs that he had removed from the Osprey's aerie the previous season.

The 21st December I examined another Osprey's aerie containing fully fledged young on Direction Rock or Byer's Island, off Rottnest Island. The nest was at one end of the rock, while the other end was occupied by scores of handsome crested Terns (*Sterna bergi*), all prosecuting their task of incubation, perfectly fearless of their large raptorial friends. I thought this somewhat remarkable, for, dearly as the Osprey loves fish, it is by no means adverse to fowl. Time did not permit of my visiting another aerie which was reported to me on Rottnest Island, but we possess good Gilbert's record of measuring one there 15 feet in circumference.

While at the Blackwood River, near Cape Leeuwin, I learned from the Misses Ellis that they robbed an Osprey's (or, as they called it, a Fish Hawk's) nest three times in one season. Each time three eggs formed the clutch. Once the birds built their nest on snags in the river, then removed to a tea-tree (*Melaleuca*) on the bank.

The following is a note referring to the Osprey, made in December, 1889, at Houtman's Abrolhos Islands, about fifty miles off Champion Bay:—"More common than the White-bellied Sea-Eagle. One day, as the German barque 'Capella' was riding at anchor in Good Friday Bay, each of the mastheads was occupied by one of the noble birds. In addition to fish, the Osprey is very partial to the little white-faced storm-petrel (*Procellaria fregata*), and a rough-tailed lizard (*Egernia stokesi*), common upon Rat Island. Lays in September."

Still further north, along the same coast, I am informed by Mr. T. Carter that he received from Fraser Island an egg of the Osprey, taken at the beginning of August, 1893.

With regard to the Pandion nesting on the eastern coast, Dr. Ramsay described eggs in 1875; and Mr. North again recently described two eggs taken by Mr. John S. Ramsay, on the 15th August, 1880, from a nest in the Wide Bay district, and another clutch of three eggs taken on the Mary River, Queensland, in 1882; while we have Mr. K. Broadbent's own valuable field observations of the Osprey made in Northern Queensland, where the bird finds its most suitable living about the mouths of the rivers, and is prevalent at Cardwell, where it breeds during the month of June. He once saw one of these birds capture a fish weighing about 5 lb., lift it from the water, and fly away with ease.

Though Gould himself shot an Osprey in Recherche Bay, Tasmania, the bird is not usually found so far south, preferring more the tropical and sub-tropical coastal line.

Breeding season extends from June to November.

7.—MEMORANDUM RELATIVE TO A VERNACULAR LIST OF NAMES FOR AUSTRALIAN BIRDS.

By Colonel W. O. LEGGE, F.Z.S., M.B.O.U.

For the last forty years (since about which time the population of these colonies has increased so as to number in its ranks collectors, field naturalists, sportsmen, and others taking an interest in the birds of this continent) the necessity for a list of suitable and applicable English names has been keenly felt. The writer brought the matter under the notice of the president of the biological section of the Australasian Association at the Hobart meeting, when it was suggested by Professor Baldwin Spencer that he should undertake the task himself, and submit such a list for the consideration of Australian naturalists at the forthcoming meeting. On the grounds that he was resident on the outskirts of the Australian ornithological region, and therefore did not occupy a central position, he declined, recommending instead the establishment of local committees to carry out the work as regards each colony. Subsequent consideration, however, led to the conclusion that this was not a practicable method, inasmuch as the birds of one colony are largely found in the adjacent colonies, and would probably receive different names at the hands of different committees. The best solution of the difficulty would therefore appear to be the compilation of a list by one naturalist, just as the original so-called English names were applied by one author—Gould—in the first instance. On the request of Dr. Stirling that a tentative list should be prepared by Mr. Campbell and myself, I undertook the preliminary work of drawing up a catalogue of names, in the preparation of which the entire group of Australian birds was examined from specimens and plates—mostly the latter—with a view to observation of characteristic features of plumage; and the conclusions as to befitting names thereby arrived at were combined with others based on a study of the prominent habits and external* structural characteristics of the various groups and genera. In conjunction with Mr. Campbell, the work was critically examined at the library in Melbourne, and all good species in Dr. Ramsay's "distribution list" were included with Gould's, excluding those in the works of both authors which recent research has relegated to the region of synonym.

At the commencement of research into the ornithology of any new country, particularly by a naturalist from abroad, who does not intend to make that country his fixed abode, the bestowal of suitable vernacular names must be a matter of considerable difficulty. The best popular names are applied in an old and well-worked region, like England, for example, as the result of the custom of generations. Names like "Dipper," "Woodchat," "Willow Wren," "Hedge Sparrow," "Tomtit," and many others have become recognised after long years of local use, and in some instances may possess obscure and almost forgotten derivations. The names are, notwithstanding, good; for they are based on habits and well-known and recognised characteristics.

Gould, who did a marvellous amount of work in a short period of research in these colonies, did not evidently trouble himself about English names that would be suitable to the coming Australian naturalist or sportsman. Hence he got over the difficulty by applying, in many instances, the *generic* classical name as the English—the worst thing that could be done as regards imparting knowledge, to beginners and amateurs, of the systematic position of these birds among their fellows. Again, we find the English rendering of a Latin specific name given as a vernacular one, such as "Textile (!) Wren" for *Amytis textilis.* It mattered not to him, as neither he nor his sons, nor his sons' sons would probably have to shoot and identify "Textile Wrens" during the future years of a thickly populated and permanently settled Australia We furthermore find such titles as *Australian* applied; applicable enough in books of other countries, speaking of our own fauna, but as out of place on the lips of resident Australians as "English Robin" and "English Thrush" would be in the mouth of the *Eton* or *Rugby* bird-nester!

The writer must plead guilty to a similar want of thoroughness in dealing with vernacular names in his "Birds of Ceylon." It seemed of no moment at the time of writing what English name was applied, and names given in former writings of authors on that sub-region were reproduced; others perhaps better could have been evolved.†

The points which it seemed necessary to attend to in compiling a list of vernacular names for our birds were—

(*a*) Names which would be suitable to the field naturalists as well, perhaps, as sportsmen of coming generations;

(*b*) Names based on (1) characteristic points of plumage, (2) vocal characteristics, (3) habits, (4) *locale* or situations inhabited, (5) external structural points;

(*c*) The elimination of all classical names used as English ones;

(*d*) The abolition of the term Australian as *locally* out of place;

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* Bill, legs, feet, tail.

† Reference is not made here to names of well-known *Asiatic* or *European* species found in the island.

(*e*) The retention of names used by European writers for waders and sea-birds migrating from abroad to these shores;

(*f*) The retention as much as possible of well-known popular* names, as is done with English birds;

(*g*) The elimination of authors' or naturalists' names applied as titles—these in some instances being superfluous (though in many others worthily applied), but in all cases being subversive of information to beginners—the proper and, at the same time, strictly complimentary place for such names being in the Latin title for the bird.†

In the work of compilation the best course as regards the treatment of classical "English" names, such as *Acanthiza*, *Gerygone*, *Sericornis*, &c., seemed to be to select a vernacular name in accordance with the conditions in paragraph (*b*). These applied, for example, to *Gerygone* suggested the term Fly-*eater*, as distinguished from Fly-*catcher*, for this aberrant and peculiarly Australasian form of small Fly-catchers which not only capture their food somewhat after the manner of Fly-catchers, but also seek for it arboreally.

In dealing with small active birds of mediocre plumage, which frequent, for the sustenance of life, trees, scrub, underwood, and so forth, the term "Tit" is apparently the best that can be applied, and, if qualified by a name denoting habit or *locale*, would seem very applicable to such small restless genera as *Acanthiza*, *Sericornis*, &c. As regards portions of Gould's English nomenclatures, such as his general term "Robin" for the genera *Petroica*, *Pæcilodryas*, *Eopsaltria*, it was found that by retaining the term "Robin" for the best-known member of the group (*Petroica*), and applying a qualifying noun to the allied genera, such titles as Tree-robin, Scrub-robin, and Shrike-robin were easily evolved. The members of the genus *Petroica* are *true* chats in their habits, flight, and deportment; and the term "Chat-robin" would have been preferable to "Robin" had it not been for the qualifying name required with the members of the allied genera above mentioned, which would have made the names of these latter birds too lengthy. Where a species is well known and universally recognised by a single name, it seems best to apply this name and add a qualifying title to the other and less-known members of the genus. *Myzantha* is a case in point. The terms "Cuckoo-shrike," "Caterpillar-eater," and others have been used in accordance with Indian nomenclature, allied species being thus known in India. The term "Frogsmouth" is used in order to get rid of that very objectionable name *Podargus*, and as being applied to the other genera *Batrachostomus* and *Otothrix* of the family *Steatornincæ* in India. It is a name well suited to the singular structure of the mouth, and presumably better than the mythical title "Goat-sucker." "Night-hawk," sometimes applied to the *Caprimulginæ*, does not accord with the mode of flight of the genus *Podargus*.

Contrary to the principle laid down in (*c*), the generic term *Pitta* has been retained, subject, however, to the suggestion that the Indian name "Ant-thrush" might well be given to this genus. *Pitta* was retained provisionally, as it is used in connection with Malayan

* Mr. Campbell did not agree on this point.

† One or two exceptions have been made to this theory in compiling the list.

and Asiatic members of this beautiful genus. In this connection reference may here be made to a certain Latin generic name, far on in the list, retained as a vernacular title: the name *Prion*, as almost universally applied elsewhere to the Blue Petrels, has been kept as an English name. There being but one member of the interesting Asiatic genus *Drongos* (Dicrurinæ) in Australia, it was thought best to characterise it simply as the *Drongo* without any qualifying term. Those minute birds, the members of the group Dicæinæ, and comprised in the genera *Dicæum*, *Piprisoma*, *Myzantha*, and *Pachyglossa*, are all styled "Flower-peckers" by writers on Asiatic ornithology; and as there is but one member (an interesting case of geographical distribution) straying beyond Malayana to Australia, it seems only fitting to follow our *confreres* in ornithology, and keep the name "Flower-pecker" for our Australian bird. The genus *Sittella* presented points of special interest as regards its English nomenclature. Though allied to *Sitta* (Nuthatches) it could not well be called a Nuthatch, owing to its different mode of nesting, but its habits suggested the name of "Tree-runner," and it was satisfactory to find that Gould has used the name in speaking of one species.

The Honey-eaters, Parakeets, and Finches, owing to their numbers and *similarity of style* in colouration, presented much difficulty in choosing more suitable names than those already existing. Salient points in colouration had to be taken as indicative of what were deemed suitable names, some of which may perhaps be revised. *Geopsittacus* has been named Owl Parakeet, as being more suggestive of the bird's singular nature than Night Parakeet, and from a desire to credit the avi-fauna of Australia with a representative—though somewhat remote—of the remarkable *Strigops* of New Zealand! The genus *Cyclopsitta* may be said to represent a number of diminutive Lorys. They are all of small size, none exceeding 5 inches in the wing, and are named in the Birds of New Guinea "Peroquets," which appears inapt, as it is the French for parakeet. It is proposed, therefore, to style them "Lorilets," as with "Swiftlet" the diminutive of Swift.

In regard to the Limicolæ, Asiatic names have been retained for those which visit our shores, and the same may be said of the Ardeidæ (Herons).

It does not appear necessary to quote further instances in justification of the new departure taken in the compilation of the "list." Only the more salient cases have been cited in this memorandum, but they point to the course adopted throughout the task.

As regards what species should stand intact or be eliminated, the new "Catalogue of the Birds of the World," published by authority at the British Museum, has been taken, as it assuredly should be, as the basis of this list. Not a few species, more particularly among the Laridæ, have been described in Australia as *new*, on characteristics which will not stand good when a large series are got together and examined. These have been, as a matter of course, expunged from the list, the work here undertaken being intended to be thoroughly up to date, in order to give future students nothing but reliable data.

There may be not a few zealous workers in Australian ornithology who will perhaps find the change of names in the proposed list somewhat radical; but, if the new titles are aptly applied, they will soon commend themselves to naturalists. It must be borne in mind that we are dealing with the birds of a new country with which as yet successive generations have not been familiar, and which have not gradually acquired popular or vernacular names as years rolled on; and that, therefore, a sudden departure from existing unsatisfactory nomenclature must be made, once and for all, to compensate for the effect of time and usage in old countries like England. It must further be remembered that we are not working so much for existing inquirers and naturalists as for the students of future generations, to whom the list now being compiled by the Australian Association should recommend itself more than any other.

8.—PYRENOCARPEÆ QUEENSLANDIÆ.

Auctore, Dr. J. MULLER (Müll. Arg.).

Major pars sequentium Pyrenocarpearum, pulchre lectae, e regione Brisbanensi et e Bellenden-Ker a cl. F. M. Bailey mihi missae fuerunt, et alias numerosas e territorio Brisbanensi misit cl. J. Shirley, et numerosas dein in vicinitate urbis Toowoomba a b. Hartmann lectas, partim ab ipso Hartmann partim a F. v. Mueller et Ch. Knight accepi.

Ill. Baron Ferd. v. Mueller, qui jam per seriem annorum indefesso ardore et benevolentia e varies Australiae regionibus Lichenes valde numerosos mecum communicavit, insuper e Queenslandia Lichenes ad Daintree River, Trinity Bay, Endeavour River, Lower Herbert River met in Mont Barilla Froze resp. a cll. Pentzke, Sayer, Persick, Wickha et Johnson lectos, mihi scrutandos misit.

A cl. Dr. Ch. Knight, Wellingtoniensi, demum largam messem speciminum pro elaboratione accepi, quae praesertim ad Toowoomba, Brisbane et in Thursday Insulis et in prov. N. S. Wales collecta fuerunt.

Ex variis his collectionibus Pyrenocarpeæ segregatim nunc expono, et quidem omnes quae hucusque in Queenslandia observatae fuerunt.

Species enumerantur 136, quarum 18 novae, sed paucae inter illas a me non visas verisimiliter cum aliis confluunt et in hoc difficillimo studio comparatione egent.

Opuscula, s. fontes bibliographici, in quibus Pyrenocarpeæ Queenslandiæ descriptae sunt, sequuntur.

KREMPELHUBER, Neuer Beitr. z. Flechten-Flora Australien's, in Verhandl. der k.k. zool. bot. Gesellschaft in Wien, 1880.

STIRTON, Additions to the Lichen Flora of Queensland, in Trans. and Proceed. of the Roy. Soc. of Victoria, vol. 17, 1881.

CH. KNIGHT, Lich. Austral. or. (in Bull., Queensl.?), p. 72, 78. A Contribr. to the Queensland Flora, 1884.

W. NYLANDER, Lichenes nonnulli Australienses, in Flora Ratisb., 1886.

F. M. BAILEY, Lich. of Queensland, in Pap. and Proceed. of the Roy. Soc. of Tasman., 1880.

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— Contrib. to the Queensl. Flora iii., in Proceed. Roy. Soc. of Queensl., 1884.

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J. Shirley, Lichen Flora of Queensland, 1888-9.
Müller Arg., Lichenologische Beitraege in Flora Ratisb., 1881-8.
— Lichenes Bellendenici in Hedwigia, 1891.
— Lich. Brisbanenses in Nuovo Giornale Botan. Italiano, v. xxiii., 1891.
— Lichenes Exot. Herbarii Vindob. in Annal. naturhist. Hofmuseums, 1892.

PYRENOCARPEÆ.

Müll. Arg., Consp. Syst. Lich. Nov. Zel., p. 15.

Trib. DERMATOCARPEÆ.

Müll. Arg., Pyrenoc. Cub., p. 377.

Dermatocarpon.

Müll. Arg., Pyrenoc. Cub., p. 377.

1. Dermatocarpon miniatum, Th. M. Fries, Arct., p. 253.—Saxicola, Toowoomba: Hartmann, n. 100.

Obs.—*Endocarpon Baileyi*, Stirt., Addit. Lichfl. of Queensland, p. 9, *non est* species *Endocarpi aut Dermatocarpi;* est enim *Leptotrema Wightii*, Müll. Arg., L. B., n. 518 et ad *Thelotremeas* pertinet.

Trib. STRIGULEÆ.

Müll. Arg., Pyrenoc., p. 378.

Strigula.

Fr. in Vet. Akad. Handl., 1821, p. 323.

Obs.—Species enumeratae omnes sunt foliicolae.

2. Strigula Glaziovii, Müll. Arg., L. B., n. 1567; in foliis *Magnoliæ grandifoliæ* in horto. bot. Brisbanensi: Bailey, n. 435.
3. Strigula complanata, v. ciliata, Müll. Arg., Pyr. Féean., p. 5. Bellenden-Ker: Bail., n. 535 pr. p.
4. Strigula plana, Müll. Arg., Pyr. Cub., p. 381; *Str. complanata*, Bailey, in Pap. and Proceed. Roy Soc. of Tasmania, 1880; in Queensland: Bailey, n. 783; Bellenden-Ker: Bail., n. 535 pr. p.
5. Strigula elegans, v. Nematora, Müll. Arg., Pyrenoc. Cubens, p. 380; *Str. Nematora*, Montg. Cub., p. 143; Queensland, ex Bailey, in Pap. and Proceed. Roy. Soc. of Tasmania, 1880.

Strigula elegans, v. genuina, Müll. Arg., Pyr. Cub., p. 380; Brisbane in fol. *Acronychiæ lævis:* B., n. 437, et in fol. *Quassiæ:* B., n. 440.

Strigula elegans, v. eumorpha, Müll. Arg., L. B., n. 919; *Str. elatior*, Stirt., Add. Lichfl. Queensl., p. 10; Queensland: Dr. Knight; Brisbane: Bailey, n. 358.

Strigula elegans, v. pertenuis, Müll. Arg., L. Exot., n. 91; Brisbane: Bailey, n. 368 pr. p.

Trib. PYRENULEÆ.

Müll. Arg., Pyren. Cubens, p. 381.

Obs.—Species omnes hujus tribus in Queenslandia lectae, excepta Phylloporina, ad cortices crescunt.

Subtrib. VERRUCARIEÆ.

Müll. Arg., Lich. Genève, p. 73, et Pyren. Cub., p. 376 et 398.

ARTHOPYRENIA.

Müll. Arg., L. B., n. 612.

6. ARTHOPYRENIA (sect. EUARTHOPYRENIA) CINEREO-PRUINOSA, Körb. Par., p. 391.—Ramulicola, Endeavour River: Persick (mis. cl. Ferd. v. Mueller).
7. ARTHOPYRENIA (s. EUARTHOPYRENIA) ATOMARIA, Müll. Arg., Lich. Genève, p. 89; Toowoomba: Hartm. (sine num.)
8. ARTHOPYRENIA (s. MESOPYRENIA) OCULATA, Müll. Arg.; thallus candido-albus, tenuissimus, e laevigato demum farinulentus; apothecia $\frac{6}{10}$ mm. lata, elato-convexa, e vestito demum nuda et nigerrima, vertice minute impresso-ostiolata et vulgo vestigiis thalli minute albo-oculata; perithecium basi aut deficiens aut tenue, ad angulos obtusum; paraphyses connexae; sporae in ascis 2-seriatim 8-nae, 14-16 μ longae et 7-8 μ latae, ovoideae, aequaliter 2-4-loculares.—Juxta Bengalensem *A. albo-atram* (Krplh.), Müll. Arg., L. B., n. 631; locanda est, a qua apotheciis alte convexis et sporis majoribus differt.—Corticola, Queensland: Ch. Knight., n. 136.
9. ARTHOPYRENIA (s. MESOPYRENIA) CINCHONÆ (Ach.), Müll. Arg., L. B., n. 615; Queensland: Dr. Knight, n. 59, 68, 311, 319, 335.
10. ARTHOPYRENIA (s. MESOPYRENIA) FALLACIOR, Müll. Arg., Pyren. Cubens, p. 404; Queensland: Ch. Knight, n. 109 (et verisimil., n. 4 et 105, ubi sporae desunt).
11. ARTHOPYRENIA (s. ACROCORDIA) LIMITANS, Müll. Arg., L. B., n. 630; *Verrucaria limitans*, Nyl., in Flora, 1866, p. 295, et Lich. Husn., p. 24; Queensland: Dr. Knight, n. 26, 47, 48, 49, 321.
12. ARTHOPYRENIA (s. ACROCORDIA) CONSOBRINA, Müll. Arg., L. B., n. 632; *Verrucaria consobrina*, Nyl., Expos. L. Nov. Caled., p. 53, et Syn. L. Nov. Caled., p. 92.—Corticola, Queensland: Dr. Knight, n. 326.
13. ARTHOPYRENIA (s. ANISOMERIDIUM) EXSTANS, Müll. Arg.; thallus pallide argillaceo-albus, submaculari-tenuis, laevigatus, apothecia 4-7 mm. lata et minora, nigra, nuda, emerso-hemisphaerica, demum vertice papillulata; perithecium leviter depresso-globosum, basi completum; sporae in ascis 2-seriatim 8-nae, obovoideae, 23-25 μ longae et 10-13 μ latae, basi acutatae, 2-loculares, loculus inferior superiore duplo brevior et angustior.—Fere cum americana *A. adnexa*, Müll. Arg., L. B., n. 626; convenit, sed thallus albior, apothecia distincte majora et jam novella nuda et aterrima, magis e thallo exstantia. —Corticola; Queensland: Dr. Knight, n. 43.
14. ARTHOPYRENIA (s. POLYMERIDIUM) GRAVASTELLA (Krplh.), Müll. Arg., L. B., n. 543 et 637; Toowoomba: Hartmann, n. 178, Ch. Knight.

15. Arthopyrenia (s. Polymeridium) zostra, Shirley, Lich. Fl. Queens., p. 174; Bailey, Cat., p. 69; *Verrucaria zostra*, Ch. Knight, Lich. of N. S. Wales, p. 39, t. 7, fig. 9; et Nyl., Lich. nonnull. Australiens, n. 34; Queensland, ex. Bail. l.c.

Mihi nomine tantum nota.

16. Arthopyrenia picea, Shirley, Lich. Fl. Queens., p. 174; in Bailey Synops. Queensl. Flora, p. 112.

Porina.

(Ach.) Müll. Arg., L. B., n. 644.

Species hic enumeratae omnes, praeter No. 30 et 31, ad sectionem *Euporinam*, Müll. Arg., L. B., n. 648 pertinent.

* Sporae 20-35 μ longae, 3-5 μ latae.

17. Porina bacillifera, Müll. Arg., L. Beitr., n. 539; Lich. Bellend., n. 71; Daintree River: Pentzke (sine num.); Bellenden-Ker: Bailey, n. 538.

18. Porina persimilis, Müll. Arg., L. B., n. 1208; Trinity Bay: Sayer, n. 12 et 12 b.

** Sporae 35-55 μ longae, 2-7 μ latae.

19. Porina africana, Müll. Arg., L. Afr. occ., n. 47; *Porina limitata*, Ch. Knight, Austr. or., p. 73, fid. specim.—Corticola; Toowoomba: Ch. Knight, n. 179.

20. Porina tetraceræ (Ach.), Müll. Arg., Pyren. Cub., p. 401; *Verrucaria nana*, Stirt., in Pap. and Proceed. Roy. Soc. of Tasman., 1880, non (Fée) Nyl., ex specim. Bail.; Queensland: Bail., n. 785.

21. Porina variegata, Fée, Ess. Suppl., p. 75; Müll. Arg., Pyrenoc. Féean., p. 23; Trinity Bay: Sayer.

22. Porina bellendenica, Müll. Arg., L. Bellend., n. 72; Bailey, Bullet. 13, p. 34.—Ramulicola, Bellenden-Ker district: Bailey, n. 532.

*** Sporae 35-100 μ longæ, circ. 10-18 μ latae.

23. Porina phæophthalma, Shirley, Lich. Fl. Queens., p. 171; *Verrucaria aurantiaca*, Bailey, Classif. Index of Queensl., 1883, non Fée; Brisbane: Bailey; *P. brisbanensis*, Müll. Arg., L. Brisb., n. 132.

24. Porina mastoidea (Ach.), Müll. Arg., Pyren. Cub., p. 400; *Verrucaria maestroides* (err. typogr.), Bailey, in Pap. and Proceed. Roy. Soc. Tasman., 1880; Brisbane: Bailey, n. 352, 353, 662; Shirley, n. 1771.

25. Porina rudis, Müll. Arg., Lich. Exot. hb. Vindob., n. 52; *P. mastoidea*, v. *rudis*, Müll. Arg., L. B., n. 540; Toowoomba: Hartmann, n. 107.

26. Porina exasperata, Ch. Knight, Austr. or., p. 73; Main Range, ex cl. Ch. Kn. l.c.

27. Porina internigrans, Müll. Arg.; *Verrucaria internigrans*, Nyl., L. Andam., p. 18; Trinity Bay: Sayer.

28. Porina glauca, Müll. Arg., Pyrenoc. Cubens, p. 399; Trinity Bay: Sayer.

29. Porina Araucariæ, Müll. Arg., Lich. Brisb., n. 131; Bailey Bullet. 13, p. 34; in cortice *Araucariæ Cunninghamii*, Brisbane: Bailey, n. 449 pro parte.

30. PORINA (sect. RHAPHIDOPYXIS) SUBARGILLACEA, Müll. Arg., L. Wils., n. 204; v. NIGRATA, Müll. Arg.; apothecia thallo delapso in hypothallo nigro maculiformi sita.
— Aliter a planta Wilsoniana non differt, quae etiam perithecia, iterum examinata, dimidiata offert. Dissectiones antea indicatae evidenter non omnino centrales erant.—Corticola, Toowoomba: Hartmann.
31. PORINA (s. RHAPHIDOPYXIS) RHAPHIDOSPORA, Müll. Arg.; *Verrucaria rhaphispora*, Ch. Knight, Lich. of N. S. Wales, p. 40, t. 7, fig. 12; et Nyl., Lich. nonull. Austr., n. 35; *Arthopyrenia rhaphispora*, Bailey, Cat., p. 69; Queensland, ex Bail. l.c.

Mihi nomine tantum notæ.

32. PORINA PRÆSTANTIOR, V. NANA, Shirley, Lich. Fl. Queens., p. 170.

PHYLLOPORINA.

Müll. Arg., Lich. Epiphyll., n. 50.

33. PHYLLOPORINA EPIPHYLLA, Müll. Arg., Lich. Epiphyll., p. 21.—Foliicola, Bellenden-Ker district: Bailey, n. 483 pr. p.

CLATHROPORINA.

Müll. Arg., L. B., n. 54.

34. CLATHROPORINA TOMENTELLA, Müll. Arg., L. B., n. 1209; *Porina farinosa*, C. Kn., Austr. or., p. 74; Toowoomba: Dr. Knight.
35. CLATHROPORINA OLIVACEA, Müll. Arg., L. B., n. 542; Toowoomba: Hartm., n. 39, 106; Brisbane: Bailey, n. 664, 665; et Shirley, n. 1614, 1772, 1782.
36. CLATHROPORINA MEIOSPORA, Shirley, Lich. Fl. Queens., p. 172; *Porina meiospora*, Ch. Knight, Austr. or., p. 73; Main Range: ex Ch. Kn. l.c.
37. CLATHROPORINA ENDOCHRYSEA, Müll. Arg., Consp. L. Nov. Zel., p. 93; Queensland, ex Bailey, Cat. of the Plants of Queensl., p. 69.
38. CLATHROPORINA DESQUAMANS, Müll. Arg., L. Brisban., n. 135; Bailey, Bullet. 13, p. 35; Brisbane: Bailey, No. 224 pr. p., 449 pr. p.; Queensland: Bail., n. 661; Shirley, n. 1592, 1602, 1852 (*apotheciis delapsis*), 1874; Lower Herbert River: H. A. Wickham.
— f. SOREDIIFERA, Müll. Arg., L. Exot., n. 96; Brisbane: Bailey, n. 370; Shirley, n. 1585, 1620.
39. CLATHROPORINA PUSTULOSA, Shirley, Lich. Fl. Queens., p. 172; *Porina pustulosa*, Ch. Knight, Austr. or., p. 73 (sporae maximae l.c. indicantur, sc. 130 mm. longae, nisi fallor); Main Range: ex Ch. Kn. l.c.
40. CLATHROPORINA ENTEROXANTHA, Shirley, Lich. Fl. Queens,, p. 171; *Porina enteroxantha*, Ch. Knight, Austr. or., p. 72 (sporis maximis a reliquis diversa videtur); Mount Perry: ex. Ch. Kn. l.c.
41. CLATHROPORINA FLAVESCENS, Müll. Arg., L. Brisb., n. 136; Bailey, Bullet. 13, p. 35; Brisbane: Bailey, n. 515.

42. Clathroporina robusta, Müll. Arg., L. B , n. 1210; Trinity Bay: Sayer.

Pseudopyrenula.

Müll. Arg., L. B., n. 602.

43. Pseudopyrenula sulphurescens, Müll. Arg., n. 602; *Arthopyrenia sulphurescens*, Müll. Arg., L. B., n. 544; Toowoomba: Hartmann.

Polyblastia.

Th. M. Fries, Polybl., n. 8; Müll. Arg., Pyren. Cub., p. 376; Körb. Par., p. 336 pr. p.

44. Polyblastia pertusarioides, Müll. Arg., L. B., n. 1109; *Pyrenula pertusarioides*, Krplh., Neüer Beitr., Fl. Austr., n. 121; Richmond River: Miss Hodgkinson.

45. Polyblastia nudata, Müll. Arg., L. Exot., n. 98.—Ramulicola, Brisbane: Bailey, n. 89.

46. Polyblastia velata, Müll. Arg., L. B., n. 1211; Endeavour River: Persick.

Hic forte pertinet *Pyrenula velata*, Bail., Cat., p. 69.

47. Polyblastia gregantula, Müll. Arg.; thallus albus, farinulentus, tenuissimus; apothecia vulgo 2-4—natim gregantula et partim in maculam griseo-seminudam irregularem confluentia, nigra, depresso-conica ad basin obtectam $\frac{40-45}{100}$ mm. lata, superne tantum nuda et ibidem $\frac{20-25}{100}$ mm. lata, basi nigro-dilatata; perithecium basi completum ibique tenuius et subplanum; asci 2-spori; sporae circ. 38 μ longae et 14 μ latae, imbricatim appositae; locelli in series transversales 8 dispositi, medio in quaque serie 4.—Juxta orizabensem *D. geminellam* (Nyl., sub *Verrucaria*), Müll. Arg.; locanda est, cujus sporae majores et cujus apothecia majora et sparsa. Habitu similior est transvaalensi *P. albæ*, sed hujus sporae sunt majores et apothecia sparsa.—Fere *Tomaselliam* simulat, sed apothecia tantum approximata et sporae aliae sunt. Habitu fere refert *Tomaselliam disporam*, Müll. Arg., L. B., n. 1206.—Corticola, Queensland: Ch. Knight, n. 298, et forte, n. 57, et 66 (ambae spermogonigerae) et 58, et 67 (ambae eximie juveniles, sine sporis).

48. Polyblastia geminella, Müll. Arg., L. B., n. 47; *Verrucaria geminella*, Nyl., Pyrenoc., p. 40; Queensland: Dr. Ch. Knight (sine num.)

49. Polyblastia tichospora, Shirley, Lich. Fl. Queens., p. 180; Ch. Kn. ap. Bailey, Cat., p. 69. Haec mihi omnino ignota est.

Microthelia.

Körb. Syst., p. 372.

* Sporae, 2-loculares.

50. Microthelia miculiformis, Müll. Arg., Pyrenoc. Cub., p. 417; Bail., Lich. Brisb., n. 137 (errore typogr., sub. *M. maculiformi*), Bullet. 9, p. 32; Brisbane: Bailey, n. 482.

51. Microthelia obovata; *Verrucaria obovata*, Stirt., Add. Lichfl. of Queensl., p. 9; Brisbane: Bail., n. 125, ex. Stirt. l.c.

52. MICROTHELIA BRISBANENSIS, Müll. Arg.; thallus testaceo-albus, tenuissimus, laevis; apothecia circ. $\frac{3}{4}$ mm. lata, nigra, juniora planiuscula, dein hemisphaerica et emersa, nuda, subopaca; perithecium basi subplanum, utrinque acute productum, sub nucleo valde attenuatum; sporae in ascis 2-seriatim 8-nae, circ. 23-25 μ longae et 8-10 μ latae, demum nigro-fuscae, oblongo-obovoideae, 2-loculares; loculi aequilongi v. inferior (paullo angustior) leviter brevior.—A praecedente *M. obovata;* recedit colore thalli, apotheciis majoribus et sporis magis aequaliter 2-locularibus.—Corticola, Brisbane: Shirley, n. 1566.

** Sporae, 4-loculares.

53. MICROTHELIA ALBA, Müll. Arg.; thallus subvirenti-albus, tenuissimus et laevis; apothecia $\frac{1}{2}$-$\frac{4}{7}$ mm. lata, juniora nana et griseo-velata, demum impure nudato-nigra et alte hemisphaerica; perithecium demum subglobosum, basi truncata innata conivens, sub nucleo deficiens aut tenuissimum; paraphyses connexae; sporae in ascis 2-seriatim 8-nae, 25-30 μ longae, 9-10 μ latae, oblongo-ellipsoideae v. obovoideae, aequaliter 2-4-loculares.—Habitu costaricensem *M. intercedentem*, Müll. Arg.; simulat, sed thallus aliter albidus et sporae subvalidiores magis divisae sunt. Sporis et apotheciis dein minoribus a *M. queenslandica* differt.—Corticola, Queensland: Ch. Knight (sine num.)

54. MICROTHELIA QUEENSLANDICA, Müll. Arg.; thallus tenuissimus et laevis, farinulentus et demum rarescentia cum epidermide fulvescens v. subtestaceus apparens; apothecia $\frac{4}{5}$-1 mm. lata, demum nudato-nigra, hemisphaerica; perithecium basi subplanum ibique in sectione verticali dilatatum, sub nucleo completum sed tenuius; sporae in ascis 2-seriatim 8-nae, oblongo-ellipsoideae, 40-48 μ longae et 14-17 μ latae, aequaliter (2-) 4-loculares.—Similis est *M. dominanti*, Müll. Arg., Pyren. Féean., p. 38; sed sporae omnino aliter divisae sunt. Est e maximis generis.—Corticola, Queensland, suis locis frequens ut videtur: Ch. Knight, n. 5, 29, 56 et plures alii.

55. MICROTHELIA SUBGREGANS, Müll. Arg.; thallus albus, tenuissimus, subfarinulentus et rarescens; apothecia $\frac{4}{10}$ mm. lata, globosa, tantum circ. quarta parte superiore emergentia ibique nudato-nigra, rotundato-obtusa, solitaria et saepe 2-5 gregatim dense approximata; perithecium undique completum; sporae in ascis 2-4-nae, 40-50 μ longae, 15-20 μ latae, oblongato-ellipsoideae, aequaliter 2-loculares v. loculi saepius extremitatem versus iterum transversim secti, unde loculi tum 4, quorum ultimi intermediis duobus multo minores. Species singularis, microcarpa, macrospora, ascis oligosporis.—Corticola, Queensland: Ch. Knight, n. 315.

56. MICROTHELIA SHIRLEYANA, Müll. Arg.; thallus maculam fuscam laevigatam efformans; apothecia $\frac{6-8}{10}$ mm. lata, sparsa, v. 2-3—natim confluentia, nigra, dimidia parte et ultra immersa, nano-hemisphaerica v. subinde conico-hemisphaerica, obsolete thallino velata, medio circumcirca anguloso-dilatata, subtus completa et basi modice convexa; sporae in ascis biseriatim 8-nae, oblongo-ellipsoideae, utrinque late obtusae, 4-loculares, e hyalino fuscae,

12-15 μ longae, 5-6 μ latae, dissepimenta demum intense obfuscata. Species haec ob sporas 4-loculares et thallum fusco-macularem insignita est. Sporae (copiose visae) jam statu juniore hyalino more *Microtheliæ* septatae sunt, nec *Pyrenularum* structuram offerunt. Habitus fere ut in obfuscata *M. thelena* (Ach.), Müll. Arg.—Corticola, Queensland: Shirley, n. 1776; Bailey ad Ch. Knight, sub n. 318.

Pyrenula.

Stitzenb. Flechtensyst, p. 148. Species enumeratae omnes ad sectionem *Eupyrenulam*, Müll. Arg., L. B., n. 890 pertinent.

§ 1. Sporae 4-loculares.

1°. Perithecium hemisphaericum, inferne subalato-dilatatum, subtus incompletum aut tenuissimum.

57. Pyrenula velatior, Müll. Arg., L. B., n. 893; Trinity Bay: Sayer.

58. Pyrenula (s. Eupyrenula) oxyspora, Müll. Arg.; thallus cum epidermide maculam rufo-fuscam formans; apothecia in sectione $\frac{7}{10}$ mm. lata, deplanato-pyramidalia, semiemersa, supra nuda, nigra, paullo nitida, vertice nec umbonata nec umbilicata; perithecium dimidiatum v. basi tenuissime completum, circumcirca alato-dilatatum; sporae in ascis imbricatim 1-seriales, 8-nae, fusiformes, utrinque obtuse acuminatae, 4-loculares, inter loculos leviter constrictae, circ. 18-23 μ longae et 7-8 μ latae.—A proxima cubana *P. deplanata*, Müll. Arg.; et costaricensi. *P. lamprocarpa*, Müll. Arg.; sporis utrinque bene acutis distinguitur.—Trinity Bay: Sayer.

2°. Perithecium subconico-hemisphaericum, subtus completum.

59. Pyrenula segregata, Müll. Arg., L. B., n. 1212; *Verrucaria aggregata* f. *segregata*, Nyl., Syn. Lich. Nov. Caledon., p. 89; Trinity Bay: Sayer.

60. Pyrenula indusiata, Müll. Arg.; thallus glauco-albidus, laevissimus, oleoso-nitidus; apothecia immersa, conico-hemisphaerica, vertice leviter emergentia et diu velamine thallino subpellucido in centro nigro-perforato obtecta et dein glauco-nigricantia, in sectione verticali $\frac{5}{10}$ mm. lata, apice velato angustiora; perithecium basi valide completum, subtus paullo convexum (basi subinde columelligerum); sporae subuniserialiter 8-nae, e hyalino demum fuscae, oblongo-ellipsoideae, utrinque obtusae, 4-loculares, circ. 13-15 μ longae et 5-6½ μ latae.—Est proxima *P. segregatæ* (Nyl.), Müll. Arg., L. B., n. 1212; a qua thallo et apotheciis indusiatis differt.—Corticola, Queensland: Shirley, n. 1878.

61. Pyrenula circumrubens, Shirley, Lich. Fl. Queens., p. 179; *Verrucaria circumrubens*, Nyl., Syn. Lich. Nov. Caled., p. 89; Queensland: ex Bailey, Pap. et Proceed. of the Roy. Soc. of Tasmania, 1880.

— v. rubrotecta; *Verrucaria circumrubens*, Nyl., Syn. Lich. Nov. Caled., p. 89; v. *rubrotecta*, Stirt., Addit. Lichfl. of Queensland, p. 9; Brisbane: Bailey, n. 124 ex. Stirt. l.c.

62. PYRENULA MAMILLANA, Trev. Consp. Verr., p. 13; Müll. Arg., Pyr. Cub., p. 411; Bailey, Bull., p. 31; *Verrucaria mamillana*, Ach. Univ., p. 279; *Verrucaria Santensis*, Tuck. ap. Nyl., Nov. Gran., p. 117; Trinity Bay: Sayer; Bellenden-Ker district: Bailey, n. 601; Russell River: Sayer, n. 5, 38; Queensland: Shirley, n. 1589, 1609, 1777, 1870; Ch. Knight, n. 26, 100, 145; Toowoomba: Hartm., n. 111, 113; Brisbane: Bailey, 701, 719.

63. PYRENULA KUNTHII, Fée, Suppl., p. 80; Müll. Arg., Pyr. Cub., p. 411; Russell River: Sayer, n. 39; Brisbane: Bailey, n. 357.

64. PYRENULA WARMINGII, Müll. Arg., Revis. Lich. Eschw., n. 7; *Verrucaria Warmingii*, Krplh., Lich. Warm., p. 395; Brisbane: Bailey (sine num.)

65. PYRENULA MARGINATA, Trev., Caratt., p. 13; Brisbane: Bailey, n. 106.

2°. Perithecium subglobosum, basi completum.

* Sporae 13-20 μ longae.

66. PYRENULA NIGROCINCTA, Müll. Arg., L. Bris., n. 140; Bailey, Bullet. 13, p. 35; Brisbane: Bailey, n. 474.

67. PYRENULA FINITIMA, Müll. Arg., L. B., n. 1213; Toowoomba: Hartmann (sine n°).

68. PYRENULA SUBCONGRUENS, Müll. Arg.; thallus vestigialis, albidus, farinulentus, mox evanescens; hypothallus cum cortice fuscidulus, maculiformis; apothecia 1 mm. lata v. leviter minora, circ. triente innata, parte emersa hemisphaerica, obtusa, impure nudato-nigra, opaca, demum superne nitida; perithecium completum, lateraliter in sectione verticali non anguloso-productum; sporae in ascis 1-seriatim 8-nae, 13-15 μ longae, 7-8½ μ latae, late ellipsoideae, utrinque late rotundato-obtusae, 4-loculares.—A proxima *P. finitima*, Müll. Arg.; differt apotheciis paullo majoribus et sporis utrinque acutatis. Etiam ad *P. Costaricensem*, Müll. Arg.; habitu bene accedit, sed recedit peritheciis globosis v. subglobosis et a *P. mamillana* differt apotheciis magis late hemisphaerico-obtusis, in sectione lateraliter non anguloso productis. —Corticola, Queensland: Ch. Knight, n. 121, 123, 135, 147.

69. PYRENULA BONPLANDIÆ, Fée, Ess., p. 74, t. 21, fig. 3; *P. aspistea*, Ach., Syn., p. 123 pr. p. (non Method.); *P. dispersa*, Müll. Arg., L. B., n. 894; Trinity Bay: Sayer.

70. PYRENULA MICROCARPOIDES, Müll. Arg.; thallus pure albus, epiphlœodes, tenuis, laevis, rimulosus; apothecia nigra, fere semiemersa, globosa v. depresso-globosa, parte nuda, hemisphaerica, nigra et nitidula; perithecium completum, basi modice tenuis; sporae in ascis 8-nae, oblongo-ellipsoideae, utrinque obtusae, 4-loculares, circ. 16 μ longae et 7 μ latae.—Inter americanam *P. microcarpam*, Müll. Arg.; et sequentim *P. melaleucam* inserenda est, et cum priore minutie apotheciorum, cum ulteriore apotheciis magis emerso-nudis congruit, at ab utraque simul thallo pure albo differt.—Corticola, Queensland: Shirley, n. 1872.

71. PYRENULA MELALEUCA, Müll. Arg., L. Brisb., n. 138, Bailey, Bullet. 13, p. 35; Brisbane: Bailey, n. 519; Queensland: Shirley, n. 1877.

72. PYRENULA PORINOIDES, Ach., Syn., p. 128; Müll. Arg., L. B., n. 901; Queensland: Shirley, n. 1869 et 1880.
73. PYRENULA MICROMMA (Montg.), Trev., Caratt., p. 13; Queensland, ex Bailey, Cat., p. 69.

** Sporae 20 μ et ultra longae.

74. PYRENULA DEFOSSA, Müll. Arg., L. B., n. 545; Toowoomba: Hartmann.
75. PYRENULA BAILEYI, Shirley, Lich. Fl. Queens., p. 179; *Verrucaria Baileyi*, Ch. Knight, in Contrib. to the Queensl. Flora, p. 90, t. 14, fig. 3; Queensland: ex Ch. Kn. l.c.
76. PYRENULA NITIDA, Ach., Syn., p. 125; Bailey, Bull. 13, p. 35; Brisbane: Shirley, n. 1580, 1605, 1634, 1657; Toowoomba: Hartm., n. 164 (hb. Ch. Knight); Queensland: Ch. Knight, n. 144.
77. PYRENULA NITIDANS, Müll. Arg., L. Bellend., n. 74; Bellenden-Ker district: Bailey, n. 531 pr. p., 543 pr. p.
78. PYRENULA MASTOPHORA, Müll. Arg., L. B., n. 597; *Verrucaria nitida* mastophora*, Nyl., Expos. L. Nov. Caled., p. 52; *Verrucaria mastophora*, Nyl., Syn. Nov. Caled., p. 88; *Verrucaria flaventior*, Stirt., Add. Lich. of Queensl., p. 9; Brisbane: Bailey, n. 122; Queensland: Shirley, n. 1601, 1652, 1656, 1856, 1862, 1864; Ch. Knight, n. 133 et plures alii; Toowoomba: Ch. Knight, n. 139.
79. PYRENULA MASTOPHORIZANS, Müll. Arg., L. B., n. 980; Brisbane: Bailey, n. 499 pr. p.
80. PYRENULA PINGUIS, Fée, Ess., p. 75; Müll. Arg., Pyrenoc. Féean., p. 33; Brisbane: Shirley, n. 1560 (forma magis dealbata); Queensland: Ch. Knight, n. 136 b.
— v. EMERGENS, Müll. Arg., Lich. Costar. I., n. 204; Toowoomba: Ch. Knight, n. 142; Queensland: Ch. Knight, n. 125, 138, et forte, n. 336 (quae sporis caret).
81. PYRENULA IMMERSA, Müll. Arg., L. B., n. 1214; Toowoomba: Hartmann, n. 670; Queensland: Shirley, n. 1809 (apotheciis jam delapsis).
82. PYRENULA ADACTA, Fée, Ess., p. 74; Bailey, Bull. 9, p. 31; *Pyrenula pulchella*, Müll. Arg., L. B., n. 900; Queensland: Bailey, n. 296; Toowoomba: Hartmann, n. 217 (antea pro *Pyrenula convexa*, Nyl., sub *Verrucaria*, determinata et in Bail., Cat., p. 69, pro hac enumerata); Brisbane: Bailey, n. 499, 504; Shirley, n. 1540, 1550, 1597, 1604, 1642, 1647, 1651.

PYRENULA PULCHELLA, v. CINERASCENS, Müll. Arg.; thallus expallenti-cinerascens, demum superficie leprosulo-solutus.—Corticola, Brisbane: Bailey, n. 296; Shirley, n. 1642, 1647.

§ 2. Sporæ 6-loculares.

83. PYRENULA SEXLOCULARIS, Müll. Arg., L. B., n. 489; *Verrucaria sexlocularis*, Nyl., Prodr. L. Nov. Granat., p. 118, et Syn. L. Nov. Caled., p. 87; Queensland: Ch. Knight, n. 44, 52.
84. PYRENULA BICUSPIDATA, Müll. Arg., L. Exot., n. 100; Brisbane: Bailey, n. 233; Queensland: Ch. Knight, n. 124 pr. p.

Obs.—Verrucaria (*Pyrenula*) *subvariolosa*, Ch. Knight, Austr. or., p. 78; tantum nominata, nec characteribus stabilita fuit.

ANTHRACOTHECIUM.

Mass., Esam. Compar., p. 49.

Sect. 1—EUANTHRACOTHECIUM.

Müll. Arg., L. B., n. 1265.

* Sporae circ. 80-100 μ longae et longiores.

85. ANTHRACOTHECIUM VARIOLOSUM, Müll. Arg., Lich. Afr. occid, n. 52; Brisbane: Bailey, n. 359; Shirley, n. 1860 (apothecia ludunt apice plus minusve late nuda, sporae magnitudine et numero); Daintree River: Pentzke, specim. manca.
86. ANTHRACOTHECIUM OCULATUM, Müll. Arg., L. Brisb., n. 144; Bailey, Bullet. 13, p. 35; Brisbane: Bailey, n. 509.
87. ANTHRACOTHECIUM MACROSPORUM, Müll. Arg., Lich. Afr. occ., n. 52; *Verrucaria macrospora*, Hepp., in Zolling. Syst. Verz. 1, p. 5; Trinity Bay: Sayer.
88. ANTHRACOTHECIUM THWAITESII, Müll. Arg., Lich. Afr. occ, n. 52; Bailey, Bullet. 9, p. 31; Brisbane: Bailey, n. 517.

** Sporae circ. 30-80 μ longae.

89. ANTHRACOTHECIUM AURANTIUM, Müll. Arg., Revis. Lich. Eschw., n. 7; *Verrucaria aurantia*, Eschw., in Mart. Icon. sel., t. 7, fig. 7, et Lich. Bras., p. 127; Queensland: Shirley, n. 1775, 1781; Bailey, n. 53, in hb. Knight; Ch. Knight, n. 124 pr. p.
90. ANTHRACOTHECIUM DOLESCHALLII, Mass., Esam. Compar. alcun. gen., p. 49.—Hic pertinere videtur *Trypethelium planum*, Ch. Kn., Austr. or., p. 77, ex icon. spor.; sed descriptio et observatio nil sunt nisi repetitio illarum *T. subplani*.—Toowoomba: Hartm.; Brisbane: Shirley, n. 1539.
91. ANTHRACOTHECIUM AMPHITROPUM, Müll. Arg., L. B., n. 599; Bail., Bull. 9, p. 31; *Verrucaria libricola*, Stirt. ap. Bail., in Pap. et Proceed. Tasman., 1880, ex specim. Bail.; Queensland: Bailey, n. 786; Brisbane: Bailey, n. 514; Trinity Bay: Sayer.
92. ANTHRACOTHECIUM PYRENULOIDES, Müll. Arg., Lich. Afr. occ., n. 52; Bailey, Bull. 9, p. 32; *Verrucaria pyrenuloides*, Nyl., Pyrenoc., p. 44; *Trypethelium pyrenuloides*, Montg., in Ann. Sc. nat., 1843, p. 69; Queensland: Bailey, n. 705.
93. ANTHRACOTHECIUM LIBRICOLA, Müll. Arg., Lich. Afr. occ., n. 52 et Pyrenoc. Cub., p. 415; Queensland: Shirley, n. 1817 pr. p.; Ch. Knight, n. 44, 322 (sine sporis), 323, 334 et forte, n. 21 (sine spor.); Trinity Bay: Sayer.

*** Sporae circ 20-30 μ longae, e 4-loculari parenchymatosae, minus divisae quam in præcedentibus, series locellorum tantum 4.

94. ANTHRACOTHECIUM CONFINE, Müll. Arg., Lich. Afr. occ., n. 52; *Verrucaria confinis*, Nyl., Chil., p. 174, Pyrenoc., p. 49; Brisbane: Shirley, n. 1559; Queensland: Ch. Knight, n. 320.
95. ANTHRACOTHECIUM DENUDATUM, Müll. Arg., L. Afr. occ., n. 52; *Verrucaria denudata*, Nyl., Pyr., p. 49; Toowoomba: Hartm. (mis. Ch. Knight).

— v. OCHROTROPUM, Müll. Arg., L. Nov. Caledon., n. 127; *Verrucaria denudata* f. *ochrotropa*, Nyl., Syn. Lich. Nov. Caledon., p. 90; Trinity Bay: Sayer.

**** Sporae 7-12 μ longae, e 2-loculari parenchymatoso-4-loculares.

96. ANTHRACOTHECIUM SINAPISPERMUM, Müll. Arg., Lich. Afr. occ., n. 52; *Verrucaria sinapisperma*, Fée, Ess., p. 86; Queensland: ex Bailey, in Pap. et Proceed. Roy. Soc. of Tasmania, 1880.

Sect. 2.—PORINASTRUM.

Müll. Arg., L. B., n. 1266.

97. ANTHRACOTHECIUM DESQUAMANS, Müll. Arg., L. B., n. 1267; Trinity Bay: Sayer; Johnstone River: Berthoud.

98. ANTHRACOTHECIUM OLIGOSPORUM, Müll. Arg., n. 1268 (in Victor. Natural. 4, p. 95, errore typogr. sub *A. strigosporo* enumeratum); Bailey, Bullet. 13, p. 33, sub *A. oligocarpo*; Herbert River: H. A. Wickham.

Subtrib. TRYPETHELIEÆ.

Müll. Arg., Pyrenoc. Cubens, p. 376 et 389.

TOMASELLIA.

Mass., in Flora, 1856, p. 283; Müll. Arg., Pyrenoc. Cub., p. 376.

99. TOMASELLIA QUEENSLANDICA, Müll. Arg.; thallus cum epidermide fulvescenti - v. subfuscescenti - pallidus., maculari-tenuis, laevigatus; stromata varie oblongata, convexa, nigra, circ. $\frac{4}{5}$ mm. lata, ex. apotheciis vulgo intime connatis formata, ad latera modice undulata, tota nuda; ostiola exigua, paullo depressa, albida; perithecia basi completa; paraphyses laxe connexae, firmae; sporae in ascis angustis 1-seriatim 8-nae, cir. 20 μ longae et 7 μ latae, ellipsoideo-fusiformes, aequaliter biloculares.—Juxta brasiliensem *T. Esenbeckianam*, Müll. Arg., Pyren. Féean., p. 20; s. *Melanothecam Esenbeckianam*, Fée, Suppl., p. 71; locanda est, a qua recedit forma stromatis et sporis brevioribus.—Corticola, Queensland: Dr. Ch. Knight, n. 46.

100. TOMASELLIA DISPORA, Müll. Arg., L. B., n. 1206; Thursday Island (Torres Straits): Dr. Ch. Knight. (*Trypethelium disporum*, Kn. sched.)

101. TOMASELLIA ACICULIFERA (Nyl.), Müll. Arg., Pyren. Cub., p. 398; Bailey, Bullet. 9, p. 31; Mulgrave River, in Bellenden-Ker district: Bailey, n. 531 pr. p.

TRYPETHELIUM.

Trevis., Syn. gen. Tryp., p. 19.

102. TRYPETHELIUM TROPICUM, Müll. Arg., Pyrenoc. Cubens, p. 393; *Verrucaria tropica*, Stirt., ex. specim. Bail., n. 784; *Verrucaria nitidiuscula*, Bailey, in Pap. and Proceed. Roy. Soc. Tasm., 1880 (fide specim.), non Nyl.; *Pseudopyrenula nitidiuscula*, Bailey, Cat., p. 69; Brisbane: Bailey, n. 465, 784.

— v. NIGRATUM, Müll. Arg.; thallus niger. Bellenden-Ker, ad ramulos: Bailey, n. 539 pr. p.

103. TRYPETHELIUM PAPILLOSUM, Ach., Syn., p. 104; Queensland: ex Bail., in Pap. et Proceed. of the Roy. Soc. of Tasmania, 1880.

104. TRYPETHELIUM OLIGOCARPUM, Müll. Arg., L. Brisb., n. 130.—Ramulicola, Brisbane: Bailey, n. 465 pr. p.

105. Trypethelium infuscatum, Müll. Arg., Pyren. Cub., p. 389; Bellenden-Ker district; Bailey, n. 599.

106. Trypethelium mastoideum, Ach., L. Univ., p. 307; *Tr. Carolinianum*, Tuck., Suppl. 1, p. 429; *Pseudopyrenula ceratina*, Bailey, Cat., p. 69; *Verrucaria ceratina*, Bailey, in Pap. and Proceed. Roy. Soc. Tasm., 1880, fid. specim.; *Trypethelium scoria*, Nyl., Prodr. Nov. Gran., p. 579; Ch. Knight, Austr. or., p. 77; Brisbane: Shirley, n. 1623; Queensland: Dr. Knight, n. 126, 326; Toowoomba: Dr. Knight, n. 91.

107. Trypethelium catervarium, Tuck., Gen., p. 260; *Verrucaria catervaria*, Bailey, in Pap. and Proceed. of the Roy. Soc. of Tasmania, 1880; Queensland: ex Bailey l.c.

108. Trypethelium Eluteriæ, Sprengl., Anleit., p. 351; *Tr. Sprengelii* Ach., Univ., p. 306; Brisbane: Bailey, n. 477; Dr. Knight, n. 352; Thursday Island: Hartm., in Lojka Lichenotheca Univ., n. 147.

— v. citrinum, Müll. Arg., Revis. Lich. Eschw., n. 24; Brisbane: Bailey, n. 473; Queensland: Shirley, n. 1794.

109. Trypethelium (s. Eutrypethelium) virgineum, Müll. Arg.; thallus rufescenti-fuscus, maculari-tenuissimus, laevis; stromata nano-hemisphaerica, ambitu subregulariter orbicularia, hinc inde geminatim v. ternatim confluentia, caeterum solitaria, extus intusque albida, laevia, subnitidula, minute nigro-ostiolata; ostiola diametro $\frac{1}{15}$ mm. aequantia, leviter depressa; perithecium assueto modo nigrum, inferne tenuius; paraphyses laxe connexae; asci biseriatim 8-spori; sporae 36-40 μ longae et 10-11 μ latae, fusiformes, 9-11-loculares.—E. structura ad *T. Eluteriae*, Sprgl.; accedit, stromatibus autem quodammodo ad *T. ochroleucum*, Nyl., vergit, ubi sporae diversissimae. A simili *T. sundaico*, sc. *Bathelio sundaico*, Müll. Arg., Lich. Victor., n. 8 (antea e sporis haud bonis ad *Bathelium* relato); differt thallo fusculo et stromatibus minoribus.—Corticola, Queensland: Dr. Ch. Knight, n. 351.

110. Trypethelium anomalum, Ach., Syn., p. 105; J. Shirley, in Bull., n. 18, p. 34; *T. platystomum*, Montg., Ann. Sc. Nat. 2, vol. 19, p. 72; ad Coorparoo, fid. J. Shirley.

Bathelium.

Trev., Syn. gen. Tryp., p. 21; Müll. Arg., Pyren. Cub., p. 376.

111. Bathelium chrysocarpum, Müll. Arg., L. Bellend, n. 65; Bailey, Bullet. 13, p. 34; Bellenden-Ker district: Bailey, n. 540.

Melanothêca.

Fée, Ess., Suppl., p. 70, t. 41 (rectif.); Müll. Arg., Pyr. Cub., p. 395; *Stromatothelium*, Trev., Syn. Tryp., p. 20, incl.; *Coenoicia*, Trev. l.c., p. 22.

112. Melanotheca subsimplex, Müll. Arg., Lich. Bellend., n. 68; Bailey, Bullet. 13, p. 34; Bellenden-Ker district: Bailey, n. 546.

113. Melanotheca oxyspora, Müll. Arg.; tota quoad thallum et apothecia similis *M. Acharianæ*, Fée; sed sporae multo majores, 28-37 μ longae, 11-15 μ latae, late fusiformes et subcuspidato-acuminatae (nec utrinque rotundato-obtusae). Sporae jam statu juniore hyalino utrinque acuminatae sunt.—Corticola, Queensland: Ch. Knight, n. 127.

114. Melanotheca Acharina, Fée, Suppl., p. 71, t. 36 et 41; Trinity Bay: Sayer, Queensland: Ch. Knight, n. 312.

115. Melanotheca cruenta, Müll. Arg., Pyr. Cub., p. 397; *Trypethelium cruentum*, Mont., Cent. I., n. 30; *Trypethelium rubrum*, Ch. Knight, Austr. or., p. 76, in Bailey, Contrib., 1884, p. 5, t. 18, fig. 5, ex ipsius specim.—Ramicola, Queensland: Dr. Knight; Bailey, n. 783; Bellenden-Ker district: Bailey, n. 539.

116. Melanotheca cinnabarina, Shirley, Lich. Fl. Queens., p. 167; *Trypethelium cinnabarinum*, Ch. Knight, Austr. or., p. 76; Queensland: ex Ch. Kn. l.c.

Mihi nomine tantum nota.

117. Melanotheca rubescens, Shirley, Lich. Fl. Queens., p. 167; and Bailey, Syn. Queensl. Flora, p. 112.

Bottaria.

Mass., Misc. Lich., p. 12; Trev., Syn. Tryp., p. 20; Müll. Arg., Pyren. Cub., p. 376, n. 15.

118. Bottaria umbilicata; Trypethelium umbilicatum, Ch. Knight, Austr. or., p. 78 (e fig. xiv., cit. evidenter ad *Bottariam* pertinet); Main Range, ex. Ch. Knight, l.c.

Subtrib. PLEUROTHELIEÆ

Müll. Arg., Pyr. Cub., p. 387.

Campylothelium.

Müll. Arg., L. B., n. 595.

119. Campylothelium defossum, Müll. Arg., L. Brisb., n. 124; Bailey, Bull. 13, p. 33; Queensland: Bailey, n. 633.

120. Campylothelium nitidum, Müll. Arg., L. Brisb., n. 125; Bailey, Bullet. 13, p. 33.—Ramulicola, Brisbane: Bailey, n. 460.

Pleurothelium.

Müll. Arg, Pyren. Cub., p. 387.

121. Pleurothelium australiense, Müll. Arg., Lich. Brisb., n. 126; Bailey, Bullet. 13, p. 33.—Corticola, Queensland: Bailey, n. 562.

Pleurotrema.

Müll. Arg., Pyr. Cubens, p. 388.

122. Pleurotrema pyrenuloides, Müll. Arg.; thallus cum epidermide fulvescenti-albidus, maculari-tenuis, laevigatus; apothecia mox nuda, emersa, $\frac{6-7}{10}$ mm. lata, subhemisphaerica, ambitu orbicularia v. pro parte leviter oblongata, nigra, opaca, apice v. juxta verticem minute ostiolata ibique nitidula; perithecium basi completum, at vulgo attenuatum; nucleus obliquus v. hinc inde fere horizontalis; paraphyses connexae; sporae in ascis

1-seriatim 8-nae, ellipsoideo-subfusiformes, 28-32 μ longae, 8-11 μ latae, aequaliter biloculares.—A proximo *Pl. polycarpo*, Müll. Arg., Lich. Neo. Caled., n. 108; in eo recedit quod apothecia majora, ambitu fere regulariter orbicularia, *Pyrenulam* simulantia, et sporae dein sunt majores et validiores.—Corticola, Queensland: Dr. Ch. Knight, n. 49, 314 et alii.

PARATHELIUM.

Müll. Arg., Pyr. Cubens, p. 388 (Nyl. pr. p.).

123. PARATHELIUM DECUMBENS, Müll. Arg., Lich. Exot., n. 93; Brisbane: Shirley, n. 1611.

Subtrib. ASTROTHELIEÆ.

Müll. Arg., Pyr. Cub., p. 382.

PARMENTARIA.

Fée Meth., p. 24, t. 1, fig. 24; Müll. Arg., Pyren. Cub., p. 385.

* Sporae circ. 20-60 μ longae, 8-nae.

124. PARMENTARIA MICROSPORA, Müll. Arg., L. B., n. 1205; *Trypethelium nanasporum*, Ch. Kn., Austr. or., p. 78; Brisbane: Shirley, n. 1610; Toowoomba: Ch. Knight, n. 120; Queensland: Ch. Knight, n. 147.

125. PARMENTARIA ASTROIDEA, Fée, Meth., p. 76, t. 1, fig. 14; Toowoomba: Hartm.; Brisbane: Shirley, n. 1532, 1631 (specimina visa omnia manca, sporis destituta).

126. PARMENTARIA BAILEYANA, Müll. Arg., Lich. Bellend., n. 64; Bailey, Bullet. 13, p. 34; Bellenden-Ker: Bailey, n. 543 pr. p.

127. PARMENTARIA SUBUMBILICATA, Müll. Arg., L. Beitr., n. 1204; *Trypethelium subumbilicatum*, Ch. Knight, Austr. or., p. 76; Toowoomba: Dr. Knight, n. 111, 137; Brisbane: Shirley, n. 1612, 1861, 1865, 1866, 1867, 1868 pr. p., 1871, 1876, 1879.

** Sporae majores, in ascis 2-nae.

128. PARMENTARIA SUBASTROIDEA, Müll. Arg.; thallus glauco-pallidus, laevigatus, nitidulus; apotheciorum rosulae similes iis *P. astroideæ*, Fée; prominulae, supra nudae, nigrae, singula globoso-pyriformia, versus centrum ostiolare vulgo fuscum angustata; perithecia completa, subhorizontalia; sporae in ascis 2-nae, fuscae, circ. 160 μ longae et 35 μ latae, crebre parenchymatosae.—Corticola, Queensland: Shirley, n. 1863.

— v. SUBSIMPLEX, Müll. Arg.; perithecia fere omnia solitaria et similia iis *Pleurothelii australiensis*, Müll. Arg.; sed hinc inde occurrunt astroideo-composita et colore thalli et reliqua omnia cum specie quadrant.—Corticola, Queensland: Shirley, n. 1875.

129. PARMENTARIA TOOWOOMBENSIS, Müll. Arg., L. Exot. hb. Vindob., n. 51; Toowoomba: Hartm., n. 108.

130. PARMENTARIA GREGALIS, Müll. Arg., L. B., n. 1203; *Trypethelium gregale*, Ch. Knight, Austr. or., p. 77; Toowoomba: Dr. Knight, n. 224; Queensland: Bailey, n. 668.

131. PARMENTARIA PAPILLATA, Shirley, Lich. Fl. Queens., p. 161; *Trypethelium papillatum*, Ch. Knight, Austr. or., p. 76; Main Range, ex Ch. Knight l.c.

132. Parmentaria subplana, Müll. Arg., L. B., n. 1202; *Trypethelium subplanum*, Ch. Knight, Austr. or., p. 77; Toowoomba: Dr. Knight, n. 143, 122? (haec ulterior sine spor.).

133. Parmentaria pallida, Shirley, Lich. Fl. Queens., p. 163; *Trypethelium pallidum*, Ch. Knight, Austr. or., p. 77; Main Range, ex Ch. Knight l.c.

134. Parmentaria interlatens, Müll. Arg., L. B., n. 826; *Heufleridium interlatens*, Müll. Arg., L. B., n. 592; *Astrothelium interlatens*, Nyl., Syn. Lich. Nov. Caled., p. 95; Queensland: Shirley, n. 1769, 1868 pr. p.

135. Parmentaria australiensis, Shirley, Lich. Fl. Queens., p. 164; *Plagiothelium australiense*, Stirt., Add. to the Lichfl. of Queensl., p. 10; Queensland: Bailey, n. 58 (ex Stirt. l.c.).

136. Parmentaria grossa, Müll. Arg.; thallus fulvescenti-pallidus, cartilagineus, laevis, reticulatim rugosus; areolae pro majore parte grosse ampullaceo-tuberculiformes et fertiles, apothecia apice aut lateraliter immersa v. etiam profunde obtecta gerentes, circ. 2 mm. latae, intus albidae; apothecia subternatim conjuncta, subhorizontalia et tum paullo nudata v. pr. p. etiam solitaria et varie immersa, praeter apicem inter se libera, tota nigra; sporae in ascis binae, circ. 110-115 μ longae et 30-35 μ latae, copiose parenchymatico-multilocellosae.—Ad. *P. australiensem;* quam non vidi, accedit, sed apothecia non in stromate communi nigro immersa et sporae minores sunt.—Corticola, Queensland: Dr. Ch. Knight, n. 100 pr. p. et 100, a. pr. p.

Obs.—*Verrucaria velata*, Turn., Ch. Kn., Austr. or., p. 78, errore typ. pro *Parmelia velata*, Turn., et dein ut videtur sub *Verrucaria velata*, Turn., in Bailey, Contrib. to the Queensl. Flora, iii., p. 6, est species Pertusariae inter Discocarpeas.

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Section E.

GEOGRAPHY.

1.—LETTER FROM THE PRESIDENT, ROYAL GEOGRAPHICAL SOCIETY, LONDON.*

1 Savile Row,
Burlington Gardens, W.,
8th January, 1895.

SIR,—I have the honour to bring to the notice of the Australian Association for the Advancement of Science the steps that have been taken within the last year with a view to the renewal of Antarctic research.

On the 27th November, 1893, a very important and interesting paper was read to a meeting of the Royal Geographical Society by Dr. John Murray, of the "Challenger" Expedition, a copy of which is enclosed. The arguments, and the detailed information contained in Dr. Murray's paper, appeared to the Council of the Royal Geographical Society to place the importance of renewing Antarctic research in such a convincing light that it resolved to take action in the matter. I therefore appointed a committee of experts to report on the points bearing on the renewal of Antarctic research and on the despatch of an expedition.

On the receipt of the report of this Society's Antarctic Committee, a copy of which I enclose, the Secretary of the Royal Society was addressed with a view to the matter receiving the consideration of the Council of that influential body. It was referred to a committee, which made its report last May. This report of the committee appointed by the Council of the Royal Society dwells chiefly on the requirements of magnetism, and shows the necessity for despatching an Antarctic Expedition for the completion of magnetic observations which are both of purely scientific and also of practical importance. The committee also points out that many other branches of science besides magnetism will be largely advanced by such an expedition. It is very encouraging to find that the President and Council of the Royal Society fully endorse the views of their committee as regards the great scientific importance of the results of Antarctic research. The Council of the British Association has also passed a resolution in approval of our efforts to obtain the despatch of an Antarctic Expedition. The other leading scientific bodies of the Empire have also been addressed on the subject with a view to combined action, and to the nomination of a deputation, representing the science of the Empire, being appointed to urge this great question on the attention of Her Majesty's Government.

An Antarctic Expedition will not yield scientific results alone. It will be advantageous to the navy and to the colonies, and will increase the prestige of the Empire.

* This letter was received after the close of the Brisbane Session, and is printed here by direction of the Publication Committee.

In the opinion of all experts who are familiar with the requirements of an Antarctic Expedition, it is essential for its efficient conduct and for its success that it should be commanded and officered by naval men, and be under naval discipline. It therefore becomes necessary to apply to Her Majesty's Government to undertake the organization and despatch of an Antarctic Expedition; and thus the question of expense arises.

There is reason to expect, from the letter addressed by the Secretary of the Treasury to the Under Secretary of State for the Colonies on the 3rd of January, 1888, a copy of which is enclosed, that, when the time comes for requesting Her Majesty's Government to undertake the despatch of an Antarctic Expedition, the co-operation of the Australasian colonies, by contributing towards its cost, will go a long way towards securing favourable consideration for the representations of scientific and other bodies interested in such an enterprise.

Although an Antarctic Expedition on a suitable scale is an enterprise that ought to be undertaken by Her Majesty's Government, the Australasian colonies are interested in its despatch and in its success, and might probably contribute towards its cost. A small grant from each colony would, it is believed, with reference to the Treasury letter of January, 1888, almost oblige Her Majesty's Government to enter upon the good and useful work of Antarctic research, while such a step must commend itself as a wise political measure. Nothing would tend more to strengthen the cordial feeling between the mother country and the colonies than co-operation in a work which cannot fail to be useful to all. When the labours of the explorers are completed, the mother country and the colonies will alike find themselves enriched by a large and valuable accumulation of knowledge, much of which will be of practical use to navigators who frequent the Australasian shores.

I trust that these considerations will commend themselves to the members of the Australasian Association for the Advancement of Science, that they will see the great advantage of this co-operation, and will use their influence to prevail upon the Australian Governments to give favourable consideration to the letters which have been addressed to their Agents-General by the Royal Geographical Society.

I have the honour to be, Sir,
Your obedient servant,
CLEMENTS R. MARKHAM,
President, Royal Geographical Society.

The Secretary of the Australian Association for the Advancement of Science.

2.—A WEST INDIA ISLAND.

By His Excellency General Sir H. W. NORMAN, G.C.B., G.C.M.G., C.I.E.

The title of the paper I am about to read is "A West India Island," and I may at once say that the island about which I propose to treat is Jamaica. My reasons for selecting this subject are that it seems to me on these occasions the topic should be one of which the author may be supposed to know more than his hearers, or more at least than most of his hearers; that it should be one which can to some extent be adequately dealt with in the limits of an ordinary paper; and that it should possess some features of interest, and perhaps of instruction, to those who are present. I think the two first conditions are adequately fulfilled in this paper. Of the third condition I cannot be a competent judge, for more than five years of my life were so entirely bound up with the fortunes of Jamaica and its people that everything connected with the island possesses for me a high interest; but I am fain to think that a brief account may not be undeserving of your attention. Perhaps, indeed, the very distance of Jamaica from this part of the world, and the very different circumstances of Her Majesty's West Indian and Australian possessions, may give an interest to my subject. I fear, however, that my account will go somewhat beyond the limits of what is usually understood by geography, but not beyond geography in its true and largest sense as a science "which treats of the world and its inhabitants—a description of the earth or a portion of the earth, including its structure, features, products, political divisions, and the people by whom it is inhabited."

Many persons who have not had occasion to visit the West Indies or to study the relative positions of the islands look upon them as one group, but this is a mistake. The islands which extend in a crescent shape, beginning in the south with Trinidad, close to the coast of Central America and just north of the 10th degree of north latitude, to the Virgin Islands, between the 18th and 19th degrees of latitude, are called the Lesser Antilles; and of the principal islands of this group eight are British and two are French, while the Danes and Dutch have possession of smaller islands. Jamaica, which is distant nearly 1,000 miles from the nearest of these islands, and is closer to the North American Continent than any of them, belongs to the group called the Greater Antilles. Exclusive of some small islands, this latter group consists, besides Jamaica, of Cuba, which belongs to Spain, with an area of 41,600 square miles and a population of 1,631,000; Haiti, which is divided into two negro republics—that of Haiti, and that of Santa Domingo—the first with an area of 10,200 square miles, and Santa Domingo with an area of 18,000 square miles, each having an estimated population of about 600,000 inhabitants; and Porto Rico, which belongs to Spain, and has an area of 3,550 square miles, and a population of 807,000. Jamaica, the remaining island of the group, has an area of about 4,200 square miles, and a population of about 650,000 souls.

Jamaica is not only, from a geographical point of view, quite separate from the other British West Indian Islands, but what I may call its political circumstances are quite different, owing to its proximity to large islands and to Central American States, in which sedition and even revolution are of common occurrence. Trinidad, of all the Lesser Antilles, is the only island that has occasional difficulty of a somewhat similar kind, as it is within actual sight of the large Republic of Venezuela.

Jamaica is 144 miles long, and about 50 miles across in its broadest part. Its eastern coast is 100 miles from Haiti, and its northern coast is 90 miles from Cuba. The island runs in length nearly east and west, and extends from 76 degrees 11 minutes to

78 degrees 20 minutes 50 seconds of west longitude, and from 17 degrees 43 minutes to 18 degrees 33 minutes of north latitude. It is distant about 5,000 miles from England, and 310 miles south-west from the nearest point on the continent of America—namely, Cape Gracias à Dios, in the Mosquito territory. Jamaica is surrounded by the waters of what is called the Caribbean Sea, which at the north-eastern part of Jamaica is styled the Windward Passage, the waters of which mingle with the Atlantic Ocean. I may here mention that Jamaica is 540 miles from Colon, the Atlantic end of the projected Panama Canal.

The island is extremely mountainous, as are the neighbouring islands of Cuba and Haiti; and the hills, especially in the eastern part of the island, where they are called the Blue Mountains, are lofty and attain a height of 7,360 feet. Speaking generally, a great central ridge runs from the eastern coast through a large part of the island; and in many places subordinate ridges run to the north and south, and vie in height with portions of the main ridge. A carefully prepared table shows that out of the 4,207 square miles comprised in the island 1,452 are at an elevation of from 1,000 to 2,000 feet; 400 square miles are from 2,000 to 3,000 feet; 74 from 3,000 to 4,000 feet; 39 square miles from 4,000 to 5,000 feet; and 24 square miles are above 5,000 feet. The climate, therefore, is very diverse; and from a tropical temperature of 80 degrees to 86 degrees at the coast, the thermometer falls to 50 degrees or 60 degrees on the tops of the highest mountains, and the climate of the mountains is delightful, especially in some of the subordinate ranges, on which there is often a good deal of fairly level and rolling ground. A good deal of the scenery is beautiful, and from many points there are magnificent views of the sea and of the lower hills and belt of plain country, which often for several miles slope gradually to the sea from the base of the mountain ranges. For instance, from Kingston, the capital, a general rise of about 100 feet in the mile for nine miles intervenes between the sea and the mountains where wheel traffic has to end, except on one specially constructed cart road which crosses to the north side, by the lowest depression in the range, at a height of 1,360 feet. Many portions of the mountains are well wooded, though there has been much unnecessary destruction of timber.

The foundation or basis of the island is composed of igneous rocks, overlying which are several distinct formations which it would be impossible for me to describe at length. I may, however, say that the only volcanic formation is in the eastern part of the island about a mile from the sea, but there is no defined crater, and the volcanic material is the only evidence remaining. There are mineral deposits in various places; and iron, copper, lead, manganese, and cobalt have been worked to some extent, but with no profitable result. Marble of good quality has also been found at the head of the Blue Mountain Valley.

There are numerous rivers and springs in the island; and some of the rivers, which have little water in them in ordinary times, cause much inconvenience and injury in times of flood. There are several mineral springs, some of which are of undoubted benefit in various diseases.

Respecting the history of Jamaica I must be brief. It was discovered by Columbus in his second voyage to the New World, on the 3rd May, 1494, and remained Spanish territory for more than a century and a-half. There is only a very scanty record of the history of Jamaica during this period, but on the 11th May, 1653, the island surrendered to an English expedition under Admiral Penn and General Venables. The troops left in occupation suffered much from want of provisions and sickness, and in 1655 an unsuccessful attempt was made by the Spaniards to regain the island. Considerable reinforcements came in that year, and among other curious arrivals was that of 1,000 girls and as many young men, said to have been "listed" in Ireland.

In August, 1660, news arrived of the restoration of Charles the Second, and from that time to the present day there has been a Governor in Jamaica appointed by the Crown, who for very many years has borne the title of Captain-General and Governor-in-Chief; the title of Captain-General, I am inclined to think, having been given in order to place the Governor on the same footing as the Governor of the neighbouring Spanish island of Cuba, who is styled a Captain-General. I may mention that Charles the Second, having been in official documents styled "Supreme Lord of Jamaica," the title, or its equivalent, has remained to the present day, and in many Commissions issued by the Governor it is set forth that they are prepared in the name of Her Most Gracious Majesty Victoria, Queen of Great Britain and Ireland, &c., &c., &c., winding up with the words "and of Jamaica Supreme Lady."

Some of the Governors in old days were men of note, some were not without stains on their reputation, and some were removed from office by order from home. At first the Governor was assisted by a Council of twelve, but in 1662 Lord Windsor came from England as Governor, with orders "to constitute a Council and to call Assemblies and to make laws, such laws to be only in force for two years unless confirmed by the King." This was the beginning of the famous Jamaica Parliament, which consisted of a Council and a House of Assembly, which met for the first time on the 20th January, 1664, and practically governed Jamaica, subject to certain powers reserved for the Governor and by the Crown and the home Parliament, for more than 200 years.

During these 200 years there were many troubles in the island from various causes of a political nature, with insurrections and outbreaks by slaves who had been brought in large numbers to Jamaica, the original Carib inhabitants soon having almost entirely disappeared, and there were operations undertaken in Haiti, or on the American coast, which, speaking generally, were not very successful, except sometimes in the matter of plunder, and which resulted in heavy losses—more from disease than battle. There were also troubles from French and Spanish enemies, and from pirates of all nations, who hovered about the Caribbean Seas; while death, generally in the shape of yellow fever, was always busy among the white soldiers and sailors and civil residents.

Towards the close of the 17th century Port Royal, which was one of the wealthiest towns in the world, from the prize money brought by buccaneers, was almost entirely destroyed by a terrific earthquake. Of 3,000 houses, only 200 remained, and in other parts of the island sugar works were destroyed; and many thousand people perished in the earthquake, or from the noxious miasma generated by the shoals of putrefying bodies that floated about the harbour. The destruction of Port Royal, which is now a fortified naval station, led to the establishment of Kingston, now the capital with a population of 48,000 souls, but which, though a flourishing commercial town, did not for more than 170 years after the earthquake, wrest the position of political capital from Spanish Town, a dozen miles off, which had been the principal town under the Spanish rule.

I must leave many interesting facts unmentioned; but at the beginning of the 19th century, when the trade in slaves was stopped, Jamaica was one of the richest colonies of Great Britain, and many families of nobles and others obtained wealth by marrying Jamaican heiresses. Most of the great sugar and coffee estates were held by absentees, and morality and behaviour usually looked for in a civilised society were at a low ebb. It is also certain that even then many estates had been mortgaged, and the number of encumbered estates had greatly increased when, on the 1st August, 1834, a further step was taken, and, by Act of the Imperial Parliament, slavery was prospectively abolished, all existing slaves being converted into what were called "apprentices," in which condition they were to remain for six years if they were field labourers, and for four years if they were domestic servants, after which period all slaves were to become absolutely free. This measure was carried despite opposition of the Island Parliament and of the bulk of the white inhabitants. Twenty millions sterling was paid by the British taxpayers as compensation to the slave-owners in the West Indies. Of this sum about £6,000,000 fell to Jamaica as compensation on account of 255,290 slaves; while for the remaining 55,780 slaves, classed as aged, children, and runaways, nothing was paid. Later on the term of apprenticeship at first fixed was shortened; and entire freedom was given to everyone from the 1st August, 1838.

No doubt this measure injured many proprietors very much, although in some cases the compensation came as a welcome help; but on the whole the island fell into a depressed state, as the manumitted slaves, to a great extent, avoided more work than they found absolutely necessary for their subsistence. Religion and morality, however, became more general; education of the negroes began to be attended to instead of being much neglected; and absentee proprietorship diminished. But it required other troubles to arise before the island began a real advance in moral and material prosperity, based on what I trust and believe to be sure foundations.

The House of Assembly, which practically ruled Jamaica, was a body elected on a very narrow and restricted franchise, and acted in the interests of the whites. The magistrates were almost all whites, and mainly planters; and most of these gentlemen looked with regret to the old slave days. The negro labourers considered they had great grievances; and some negroes, or semi-negroes, who were in Parliament or who wrote to the Press, did what was in their power to inflame the negroes against the Government. In 1865 a drought had devastated the provision grounds and deprived the peasantry of their usual food, while the American war and some increased taxation on imports had made costly the supply of breadstuffs. Many inflammatory and seditious speeches were made; and on the 11th October, 1865, actual outbreak occurred, and at Morant Bay, where volunteers had been assembled in anticipation of disturbance, a body of armed negroes entered the town and declared for war. They overpowered a small body of volunteers, the captain being hacked to death after being wounded, and all the officers and many of the men perished in the discharge of their duty. The custos or principal magistrate of the parish, the curate of the town of Bath, the inspector of police, and several other persons were murdered. Other outrages were committed in the neighbourhood; but Mr. Eyre, the Governor, and the military and naval authorities acted with vigour. Troops and volunteers were speedily in the field, and the insurrection was not given time to spread beyond the eastern part of the island. Within three days from the first intelligence of the rebellion reaching Kingston, it was headed, checked, and hemmed in, and within a week it was fairly crushed. The greatest credit was due to the Governor and those who directed the actual movements for the suppression of the insurrection; but a commission sent from England, after long inquiry, reported that the punishments inflicted during martial law were excessive, that the punishment of death was unnecessarily frequent, that the floggings were reckless and at Bath positively barbarous, and that the burning of 1,000 houses was wanton and cruel. The commission also reported that the disturbances had their origin in a planned resistance to lawful authority, and that "a principal object of the disturbers of order was the obtaining of land free from the payment of rent." Her Majesty's Government, "while giving Mr. Eyre full credit for those portions of his conduct to which credit was justly due, felt compelled by the result of the inquiry to disapprove of other portions of his conduct," and declined to replace him in the government of the colony. Mr. Eyre, who, I may remark, had rendered good service as an explorer on this continent, therefore left Jamaica.

Before he left, however, the Legislature of Jamaica had, at his instance, passed a law to abolish the existing Constitution and to empower the Queen to create and constitute a Government for the island in such form and with such powers as might seem to Her Majesty to be best fitting. This brought to a close in a very remarkable way representative institutions which had existed for 202 years, and which had exercised powers in some respects in excess of those of the British House of Commons.

In August, 1866, Sir John Peter Grant arrived in Jamaica as the first Governor under the new Constitution, and brought with him an Order in Council establishing a form of government, and by this there was to be a Legislative Council, which at first consisted of the Governor, six official and three non-official members, the latter being afterwards increased. A Privy Council, which answered somewhat to the Executive Council of other colonies, was also established. This Council was to consist of the Governor and certain high officials; and I may mention that this latter Council continues at the present time, with the addition, in 1888, of two non-official members. It will be understood that in Jamaica, when official members are spoken of, permanent officials are meant, for in Crown colonies, or in those having representative but not responsible Governments, there is no such thing as goverment by party—through Ministers who require the support of a majority of members of the Legislature or Parliament.

Sir John Peter Grant had long Indian experience, and had been Governor of Bengal. He was a vigorous administrator, and although he exerted himself to look after the finances, which were not in a flourishing condition, he introduced improvements in almost every department, and for the first time made the Educational and Police Departments really efficient. In some matters, perhaps, he made mistakes, and expenditure increased, but the island was in a far better condition when he left, after a period of seven and a-half years as Governor, than when he arrived.

Sir John Grant was succeeded by Sir William Grey, also a Bengal civilian, and also ex-Lieutenant-Governor of Bengal. Ill-health compelled him to relinquish office in less than three years, but he carried forward the improvements initiated by his predecessor. During his government the island suffered much from a hurricane in November, 1874, from a severe drought in 1876, followed by heavy and continuous rain which did unusual damage, from an outbreak of smallpox, and from financial panics and failures which arose, as is so often the case, from overtrading on fictitious capital.

Sir Anthony Musgrave, the late Governor of this Colony of Queensland, assumed the government of Jamaica in August, 1877, and remained until the month of April, 1883. During his government the Jamaica Railway, which belonged to a company, and extended from Kingston to Old Harbour, a distance of twenty-three miles, was taken over by the Government. This railway was constructed in 1844, and is, I believe, the oldest colonial railway. It had been allowed to fall into a very inefficient condition, but was put into good order by the Government, and two extensions were made—one of twenty-nine miles from Spanish Town to a place called Ewarton, at the foot of the St. Ann's Hills; and another from Old Harbour to Porus, at the foot of the Manchester Hills, a distance of twenty-four miles. Sir Anthony Musgrave, among other benefits conferred on the island, caused the electric telegraph to be extended in various directions, and especially to all ports; and this measure, conjoined with the establishment of a subsidised steam vessel service at short intervals round the island and to New York, rendered it possible to create the great fruit trade which has been in existence for several years, and which has done much for the people of Jamaica, and has been a compensation for the shutting up or the division of many sugar estates.

Sir Anthony Musgrave had various difficulties to contend with. There was financial depression, while floods, a long drought, and a cyclone all inflicted much loss. A calamitous fire also occurred in Kingston, in December, 1882. To meet the financial deficit, increased customs and excise duties were resorted to in November, 1884, but the former were restored to the previous rate in the following year.

A large party had now been formed, who agitated for a return to government by representation, and who, while condemning increased expenditure, ignored the many benefits and improvements of the years of Crown Government, and wished to have a hand in the control of the administration. A regular agitation in this direction was commenced, and the Secretary of State was induced, towards the end of 1882, to send out a Royal Commission to inquire into the public revenue, debts, and liabilities of the island. It seemed probable that before long some return to representative government, wholly or in part, would take place; but the actual change was no doubt hastened by the peculiar circumstances which I shall now detail. In the early part of this paper I mentioned that Jamaica had special difficulties of its own, arising from its proximity to foreign possessions. I have no doubt you are aware that in the Haitian Republic revolutions follow one another in rapid succession. These revolutions are often accompanied by terrible butcheries, and the leaders of the party that has been defeated can often only escape death by flying to Jamaica. The great Island of Cuba, though held by 20,000 of the troops of Spain, is permeated with sedition, and from this place, too, the only safe haven for escape is Jamaica. Once in Jamaica, these people take advantage of the liberty of an English possession to hatch fresh rebellions, and to make Jamaica a starting point for a new insurrection. Our law renders it difficult to do more than to keep careful watch, and be ready to interpose to prevent arms being sent away or expeditions being fitted out and despatched. The Central American Republics of Columbia, Costa Rica, Ecuador, Guatemala, Honduras, Nicaragua, Salvador, and Venezuela are more distant from Jamaica than Haiti or Cuba, but they are near enough to make Jamaica convenient as a base from which to commence or help on the frequent struggles that occur in these republics, especially as it is known that the Governor of a British possession cannot interfere one iota beyond the limits of the law which prevails, or act in anticipation of a breach of the British law in such matters. At the same time, the Governor is bound to put the law in motion, to prevent a breach of the neutrality laws, the instant he is able legally to do so. As the law is sometimes of doubtful interpretation, and as these eight republics are much given to revolutions, and comprise between them an area of 1,400,000 square miles, and a population of more than 9,000,000 strife-loving people, the Governor of Jamaica has many embarrassments usually unknown to Governors elsewhere, and these difficulties take a very unpleasant shape when he is made a defendant for damages in his own Supreme Court for overstepping his not very well-defined powers in his anxiety to prevent a British possession under his control from becoming a base from which war in foreign territory can be aided and abetted.

Two Governors at least, in recent times, have come under the power of the Supreme Court of Jamaica in consequence of action taken or authorised by them to prevent breaches of neutrality. I mention the last case only, for both cases were somewhat alike, and both, but especially the second, of these actions hastened, as I have already said, an important change in the Constitution of Jamaica.

In July, 1881, two actions were tried in the Kingston Circuit Court, at the suit of General Palido, of Venezuela, against the Governor, Sir Anthony Musgrave, and the Collector of Customs, for the detention in 1877 of the schooner "Florence" and her cargo of arms and ammunition. Damages were laid in the two cases at £10,000. The vessel had, on her arrival at Port Royal, reported herself in distress, and, after landing her cargo of arms and ammunition at Port Augusta, had been permitted to enter Kingston Harbour for repairs. On the completion of her repairs, the captain was required by the Governor, on the advice of the Attorney-General, to enter into security to proceed direct to St. Thomas, her reputed destination, and which belongs to Denmark, with her cargo of arms and ammunition. £1,000 was lodged in the Treasury by the consignees, which was repaid on the production of a certificate from the British Consul at St. Thomas of the fulfilment of the contract. It was for the delay and the contingent expenses that the actions were instituted. The verdicts were for the plaintiff, the damages being assessed at £6,700. The amount, with the costs in the suit, were paid by the Governor, as an advance from the Treasury, to save the interest and also the possible indignity of having his property levied upon to liquidate the claim. Sir Anthony Musgrave, however, in referring to the Secretary of State for instructions as to how the damages and costs were finally to be paid, expressed his readiness to pay the amount himself, if so ordered. I need not go at length into what followed, but the Secretary of State ordered a vote to be taken in the Legislative Council for the payment of the money from the Jamaica revenues. The despatch required the official members to support the vote. This decision was protested against, and two of the official members, the Auditor-General and Crown Solicitor, resigned their seats, while a Select Committee to whom the despatch was referred reported "that the Council would not be justified in sanctioning the vote, as the detention of the vessel was made entirely to protect Imperial interests, and in no way would this island derive any benefit therefrom." Public meetings were held in support of this view, and various petitions were presented against the passing of this vote, and the Governor, in reply to a further reference home, was told that a vote for half the amount would be presented to the Imperial Parliament, but that half must be paid by Jamaica. A vote for the sum was accordingly presented to the Council, and carried by the votes of eight official members, who were required by the Secretary of State, as already stated, to support the vote. The six unofficial members, who were in the minority, resigned their seats, and it was found impossible to obtain any gentlemen of sufficient position to accept seats in the Council, which therefore remained a Council wholly composed of officials.

At this time there was great excitement, and various grievances of the people were publicly urged. A strong party at home, with members of Parliament from both sides of the House of Commons, agitated for a grant of a liberal form of government to Jamaica, if not for a return to the ancient Constitution.

The Royal Commission already referred to made a comprehensive report on the affairs of Jamaica in the early part of 1883, and submitted many recommendations as to administration and finance.

Sir Anthony Musgrave left the island on expiry of office, and on appointment to this colony in April, 1883; and for some months the government was carried on with much good judgment by Major-General Gamble, who was in command of all the troops in the West Indies. Meanwhile the agitation for a change in the Constitution was continued in the island and in England.

At the end of October I was appointed Governor, and arrived on the 21st December, charged, among other matters, with the duty of introducing a representative form of government on certain lines laid down, and of considering each of the proposals of the Royal Commissioners. The first duty involved the settlement of a franchise and the formation of electoral districts; but by the end of June all my proposals had been considered in England, and I was able to proclaim an Order in Council by Her Majesty granting a new Constitution and ordering the registration of voters. Elections took place in September, and the newly formed Legislative Council was opened on the 30th of that month.

I will presently describe the form of the new Constitution, which, though at first thought not sufficiently liberal by some of the political leaders, has worked with considerable success to the present time.

During the period of more than five years during which I remained in Jamaica, and during the last six years in which Sir Henry Blake has been Governor, it may, I think, be affirmed that Jamaica has made good progress, and many measures of improvement have been carried out. Drawbacks and troubles there have been, and in my time there were, in addition to the almost inevitable drought and floods, a cyclone and a prolonged epidemic of smallpox. Various interesting events took place in these eleven years, but I must hasten on, and merely say that I believe there are now few possessions of Her Majesty of which the inhabitants are more loyal, and, I believe, contented.

By the Queen's Order in Council, the new Legislative Council was to be composed of the Governor as President, the Senior Military Officer, the Colonial Secretary, the Attorney-General, and the Director of Public Works, not more than five other members to be appointed by the Crown, and nine elected for the nine electoral districts into which the island was divided; but it was provided that not more than two, instead of five, members were to be nominated by the Crown for the present, as it was desired to give the elected members a majority, and not only have the latter remained with this majority, but it was laid down that, in any case affecting finance in which two-thirds of the elected members agreed, no resolution or Bill was to be carried adverse to the views of that proportion of the elected members. Speaking generally, this legislative body has much the same power as Colonial Parliaments, but without the means of forcing a change in the members of the Executive Government.

Some change was subsequently made in the franchise first proposed, and since 1886 every male British subject of twenty-one years of age and upwards, and who has no legal incapacity, can vote, provided he—

- Is an occupier as owner or tenant of a dwelling-house within the electorate, capable of being rated in respect of all poor rates, and has paid taxes to the amount of not less than 10s. in the year; or
- Is possessed of property on which he has paid taxes to the amount of not less than £1 10s. in the year, and ordinarily resides within the electorate; or
- In the electorate in which he claims to vote, is in receipt of an annual salary of £50 or upwards.

The number of registered voters in 1893-94 was 42,266, or about 30 per cent. of the adult male population.

I will now give a few particulars concerning the island at the present time.

By the last census the population, as I have already said, was 639,491, and is now estimated at 650,000. Of these about 2 per cent. are white. The remainder are, with the exception of 12,000 Indian coolies and 200 Chinese, chiefly of African descent, and four-fifths are pure negroes. The average annual birth-rate for the last seven years has been a fraction under 37 per 1,000, and the death-rate about $23\frac{1}{2}$ per 1,000. The negroes are a prolific race; but the mortality soon after birth and in early infancy has been great, owing to bad nursing—a state of things which, it is hoped, will improve, as a training hospital for nurses combined with a lying-in hospital was established as a memorial of the Queen's Jubilee. In 1663 the whole population was estimated at 17,272, of whom 7,762 were whites; 100 years ago it was estimated at 291,400, of whom 30,000 were classified as white; at the emancipation in 1834 the population was 371,000, of whom 311,000 were slaves, 45,000 free blacks or of mixed blood, and 15,000 whites. From 1861 to the present time there does not seem to have been a material change in the number of white persons; and the increase in population in that period, of from 441,264 to 639,491, is an increase of black or coloured people. From 1881 to 1891 the increase of all inhabitants was about 10 per cent. There is little or no immigration, except of Indian coolies to an extent which about replaces those who return to India or die on the island. There is also little emigration, though during the progress of the work on the Panama Canal thousands of able-bodied Jamaicans went there for employment, and suffered much from disease and from other causes. Many of these men returned to Jamaica with considerable sums of money; but eventually when the works closed a large number, who were left on the isthmus without means, had to be brought back to Jamaica at the cost of the island.

Taking the population at 650,000, I may remark that, if this colony of Queensland had a population in the same proportion to area as Jamaica, we should have about 103,000,000; and although, no doubt, there is a good deal of land here on which settlement is improbable, there are even in Jamaica 365,828 acres out of 2,720,000 which are useless, as being swamps, rocks, or inaccessible. There is room in Jamaica for a much larger population. Indeed, while in Jamaica the population is about 154 to the square mile, Barbadoes supports, though with difficulty, no less than 1,098 souls to the square mile.

I have already said that practically Jamaica has no mineral products of value at present. The negro inhabitants grow everything in the way of food that they want for their own consumption, except salted fish, salted meat, and breadstuffs. Of these articles large quantities are imported. The total imports in the year 1892-93 were of the value of £1,941,481, or, say, at the rate of £3 per person per annum. Of the imports, food and drink were of the value of £804,683; and of the total value 56 per cent. was from the United Kingdom, 34 per cent. from the United States, 7 per cent. from Canada, and 3 per cent. from other countries.

The value of the exports in the same year was £1,759,806, or at the rate of about 54s. per head. Of the articles exported, food and drink are of the value of £1,307,543; raw material, £388,866; and manufactured articles, only £13,172. The great market for Jamaica is the United States, which takes 54 per cent. of the exports; while the United Kingdom takes 29 per cent., and Canada $2\frac{1}{2}$ per cent. The principal articles of export and their value are as follow:—Fruit, which principally consists of bananas, oranges, and cocoanuts, £400,504; dye woods, £356,752; coffee, £340,565; sugar, £241,683;

rum, £191,055; pimento, £59,284; and what are called minor products, of which ginger and cocoa form a large portion, £95,263.

This statement shows that fruit, which is mainly grown by the peasantry, is now the staple product of the island. Twenty years ago it was hardly known as an export. It is now a valuable factor in the prosperity of the people, and, practically, the price comes into the pockets of the inhabitants, and does not go towards maintaining absentee proprietors in the United Kingdom. It is of interest here to note, as bearing on the progressive prosperity of the island, that, while in 1880-81 there were 76,035 taxpayers, the number had increased to 113,167 in 1892-93, and there are now 94,172 holdings in the island, of which 73,296 are of an area less than five acres, and 9,368 are from five to ten acres. I may mention that a negro who holds two or three acres or upwards is in fairly comfortable circumstances.

When we come to consider revenue and expenditure, we find that both are on a much more moderate scale in Jamaica, in proportion to population, than is the case in Queensland—a circumstance which, to some extent, is accounted for by the larger area of this colony and the generally higher cost of living and higher wages.

In Jamaica, in 1892-93, the general revenue, as distinguished from parochial revenues and from a small revenue raised for immigration, was £713,759; and the expenditure, including £32,905 payment to sinking funds in extinguishment of debt, was £707,179—in each case approximately about 22s. per head per annum. Here the revenue and expenditure may be reckoned at about £8 per head—a very large difference. The debt in the case of Jamaica is equal to about £2 7s. per head, with an interest and sinking fund payment of, say, 2s. 4d. a year. In Queensland the debt is about £74 per head; and the annual burden, which does not provide any fund for reduction of debt, is not much under £3 per annum. A large part of the debt of Jamaica, as is the case here, was incurred in constructing railways. The parishes, like the divisional boards here, collect revenues which are expended under certain laws for local purposes, mainly for roads and poor relief; for the former the parishes raised £31,000 in 1892-93, and they raised nearly £40,000 for poor relief. Each parish has an elected parochial board, which controls all purely local affairs; and as respects poor relief, the law for which is based on the Scotch model, these boards are to a certain extent subject to a central board of supervision, but only the infirm and those who are absolutely unfit to work are received into the poorhouses or given permanent help.

There is a regularly organised medical service throughout the island; and besides the general hospital, lying-in hospital, lepers' home, and lunatic asylum, there are eighteen hospitals in different parts of the island.

The education of the people was a good deal neglected at the period of the emancipation, and was first placed on a really sound basis in 1867. The schools, which in 1868 numbered 286, had risen to 912 in 1893; and the number of pupils attending the schools had increased in the same period from 19,761 to 99,769. There is still a large portion of the population who cannot read or write, but the abolition of all fees in the elementary schools in 1892 will no doubt greatly help forward the progress of education. The elementary schools are connected with the various religious denominations; and of the whole

912 schools, 287 belong to the Church of England, 243 to the Baptists, 131 to the Wesleyans, and 77 to the Moravians. All these schools are subject to inspection and supervision by the inspectors of schools, on whose reports grants in aid are given under fixed rules, and grants are also given in aid of building. There is a training college for schoolmasters, and another for female teachers. There is a high school for boys near Kingston; and there are several schools in different parts of the island of a superior class, which are conducted by religious bodies, or are helped by funds left in trust for the purpose. A scholarship in England of the value of £200, tenable for three years, is open to competition each year.

The judicial system comprises a Supreme Court with three judges, fourteen paid resident magistrates, with a large number of justices of the peace; and there is a police force of 770 of all ranks, organised much on the footing of the Royal Irish Constabulary. There is a regular prison department, and there are industrial and reformatory schools for boys and girls.

I must not omit to mention that there is a botanical department in the island, with large gardens and plantations at different elevations, where much experimental cultivation is carried on. It is, no doubt, greatly owing to the exertions of this department that the fruit trade has become so important, and there now seems a prospect of tea being grown in some quantity. The cultivation of cinchona, which was commenced with some spirit several years ago, has not been so successful as was anticipated. This, no doubt, has been in some measure due to the great fall in the price.

It is interesting to note that nearly all the valuable trees and plants which now abound in Jamaica have been brought from other parts of the world. The sugar-cane, coffee, the logwood, the mango, the nutmeg, the bamboo, and many others have all been imported, as well as the guinea-grass, which enables large quantities of good cattle and horses to be raised and nourished.

It is not right to omit to allude to what is one of the greatest drawbacks of the island—the plague of ticks, which prevails more or less all over the island; and the mongoose, which was originally introduced to kill the rats that destroyed the cane, has now become a formidable enemy to the poultry and to all ground game.

Jamaica is singularly destitute of wild animals and beasts of prey. Neither deer, nor bears, nor wolves, nor hyenas, or jackals, or leopards, or larger beasts of prey, or monkeys are to be found; and one animal peculiar to Jamaica and one or two other parts of the world, and which is mentioned in Scripture as the cony, is very scarce. There are snakes, but none of them have deadly poison.

Birds are numerous, and prominent among them are various kinds of beautiful humming birds and the very handsome Jamaica robin. Perhaps the most useful of the birds is the John Crow, a bird which as a scavenger is most painstaking.

Fishes are numerous all round the island and in the rivers, but this source of food supply is not made sufficient use of in Jamaica, any more than it is in other countries that we know of.

The main roads throughout Jamaica are maintained in excellent order, and are 1,800 miles in length. There are also good parochial roads, though in the mountainous country these are only suitable for footmen and horsemen and for pack transport.

The railways, which now belong to a syndicate, had in 1893 a completed length of about 100 miles, and are being steadily extended. The electric telegraph goes all round Jamaica, and to all places of any importance in the interior.

Labour is not as cheap as might be expected, and is said, taking all things into consideration, to cost more in Jamaica than in England. An imported coolie, besides quarters and medical attendance, receives 1s. per day; and the negro labourer, from 1s. 6d. to 2s. per day near Kingston, and rather less in the country districts. There is, in fact, often a scarcity of labour for the estates.

The defence of Jamaica, naval and military, is provided for at the expense of the British Government, except as respects the cost of a force of volunteer militia of 530 men, which is maintained by the island. The military force amounts to about 1,500 of all ranks, of which about two-thirds are negroes, and costs about £106,000 a year. The great harbour of Port Royal, with its curious natural breakwater, is defended by batteries, and is an important coaling station of the Empire. There is a naval commodore, dockyard, naval hospitals, and depôt ship; and besides annual visits from the fleet, Jamaica has usually one or two vessels of war in port or on its coast.

I have not time to describe the two interesting dependencies of Jamaica. One—the Turks and Caicos Islands group—is situated between 21 degrees and 22 degrees of north latitude and 71 degrees and 72 degrees 37 minutes of west longitude, and about 400 miles from Jamaica, and has a population of 4,750; and the three islands of the Caymans are between the meridian of 70 degrees 44 minutes and 81 degrees 26 minutes west and the parallels of 19 degrees 44 minutes and 19 degrees 11 minutes north. The Grand Cayman is 178 miles from the nearest point of Jamaica. The population of this group is 4,322.

I have been compelled to omit information on many points, as my paper is of too great a length without them. I have described, at all events to a certain extent, an important British possession, of the future of which I am very hopeful. When we consider the difference between the Jamaica of 100 years ago and of to-day, I feel sure that we may expect great things in two or three more generations. The Jamaican of to-day is a loyal subject; has usually attended school; is generally a supporter of some church; is very law-abiding, as is shown by the small ratio of crime as compared with many other places; and is kind-hearted and hospitable. He is still inclined to superstitions, which have come down through many centuries of barbarism, but I firmly believe he is improving in this respect; and I look back upon five years spent among Jamaicans with grateful recollections. Nor can I close without calling attention to the fact that a great mixed race is increasing in Jamaica, many of whom are highly educated, and hold positions of importance and trust. This class is already very numerous, and in the course of time will probably be leaders to a great extent of all important movements in the West Indies; and I am happy to number among them many friends of superior education and ability, and who are deservedly respected by all who know them.

3.—COREA.

Communicated by CHRISTOPHER THOMAS GARDNER, C.M.G., F.R.G.S., M.R.A.S., &c., &c., Her Majesty's Acting Consul-General, Corea.

PAPERS ON COREA.

I.—GENERAL PAPER ON COREA.

By CHRISTOPHER THOMAS GARDNER, C.M.G., F.R.G.S., M.R.A.S., &c., &c., Her Majesty's Acting Consul-General, Söul, Corea.

H. M. Legation,
Söul, Corea, 10th September, 1894.

Dear Sir,—Early this year I received a request from you to write a description of Corea for your Society. As I only arrived in this country last January, I thought the best way of fulfilling your wishes would be to ask the aid of gentlemen who had been long in the country; and after studying all the works on Corea I could lay hands on, and after obtaining all the information I could from my friends, to write a paper conveying my general impressions, suitable to be read before your Society, throwing in full and detailed notes on special subjects which, though perhaps too technical to be suitable for reading, might be of interest to the reader of your journal of proceedings. My friends most kindly responded to my request, and I beg to call special attention to the extremely interesting papers written by Messrs. Gale, Hunt, Warner, and Trollope. All four gentlemen have resided long in the country, and speak the language.

On one point only do I differ, and that is—Mr. Warner speaks of Corean tobacco as coarse. For the last month I have smoked nothing but Corean tobacco, and find it very good, both for cigarettes and smoking in an ordinary English pipe. I think tobacco might become a large export from this country.

Speaking of investment, no better charitable investment could be made than in the hospitals established by Bishop Corfe. They are at present supported by the officers and the men of our navy. The only limit to their usefulness is limited income. These hospitals are managed on a most economical basis. The Coreans have great confidence in them; and should any of your Society wish to do a good work, the establishing extra beds or an extra ward would relieve much suffering.

I am, Sir, your obedient servant,
CHRIS. GARDNER.

The General Secretary, Australasian Association for the Advancement of Science.

A glance at the map shows that Corea is a mountainous peninsula running southwards from Manchuria, from which it is divided on the north-west by the Yaloo River and on the north-east by the Tiu-men River. This peninsula is situated to the west of the islands of Japan, from the nearest of which it is only forty miles distant. Though Corea is so close to China and Japan, the people who inhabit the peninsula are a perfectly distinct race from the Manchus, Chinese, and Japanese, and have a distinct language and a peculiar character of their own. With regard to the origin of the Coreans we know nothing. If we try to trace their historical beginnings, we are lost in fogs of Chinese myths and Japanese variations of them, while our knowledge of the Corean language and superstitions is as yet insufficient to enable the ethnologist or philologist to help us solve the problem.

With regard to Corean history, the main fact to be borne in mind is that for centuries Corea has been a shuttlecock between China and Japan; that China has ever been the friend and protector of the Coreans, and the Japanese have ever been the enemies of the Coreans; that in the times of Chinese weakness Japan has made raids on Corea, accompanied with ruthless acts of massacre and cruelty; that in all these raids Japan has at first carried everything before her, but that China has in the end slowly and deliberately driven the Japanese from the country. The moment the Chinese have driven the Japanese out, they have themselves retired from the country, and left the Coreans to govern themselves and to peacefully develop their own prosperity. China, in her foreign relations, does not on the whole cut a very creditable figure; but the whole history of her conduct to Corea shows China in a very favourable light—in fact, her conduct towards her weaker neighbour might serve as an example to many Christian States, and, as conduct of a non-Christian State, it is unique in the world's history.

In the tenth century of our era the Coreans were divided into three States, called respectively Korai, Potzi, and Sinra. Korai embraced the northern part of Corea and part of Manchuria, and has always been enthusiastic in its devotion to China. Potzi embraced the centre of Corea, in which is situated the old capital, Songto, and the present capital, Söul. Sinra embraced the south of Corea, and the islands of Tchushima and Goto which now form part of the dominions of Japan. In the beginning of the twelfth century the Chief of Korai subjugated Potzi and Sinra, and formed the kingdom of Corea, which was then called the Kingdom of the Three Han, the Han being a Chinese dynasty which reigned B.C. 200 to A.D. 200, and from which the Coreans believed themselves to be offshoots. The centre of Corea, Potzi, has been always adverse to all foreigners; it has always advocated Corea for the Coreans; and it has been its exclusiveness that has made the title "Hermit Nation" so appropriate as a designation of the country. With regard to Sinra, owing to its vicinity to Japan and the constant trade between it and Japan, it was not quite as adverse to Japan as the States of Korai and Potzi.

In the thirteenth century the Mongols conquered China, and the King of Corea (Korai now giving the name to the whole peninsula) had no resource but to yield reluctantly to the great Khan Kublai, who seated himself on the throne of China.

The descendant of this king, in the fourteenth century, when the Mongol power was declining, still adhered to the cause of the descendants of Kublai Khan; but a noble of the name of Li-tan had the discrimination to pin his faith in the cowherd who ultimately drove the Mongols from China and established himself as Emperor, founding the celebrated Ming dynasty.

As a reward for the aid given him, Hungwu, the first of the Ming dynasty, made Li-tan king of Corea in A.D. 1392. The present king is a descendant of Li-tan. Li-tan, on ascending the throne, changed the name of the country from Korai (Corea) to Chaohsien, land of the "morning calm," pronounced "Chôs-sen." In the sixteenth century there rose a quarrel between the Chinese and Manchu Tartars, and Japan seized the opportunity to invade Corea in A.D. 1592.

Previous to this invasion Corea had, under the fostering influence of China and the liberty she enjoyed, made marvellous progress in prosperity and in the arts.

Her armies had occupied vast regions in Manchuria; her fleet had defeated the Japanese and ravaged the coasts of Japan. In peaceful arts her ceramics and silks were the admiration as her wealth was the envy of the East. But six short years, 1592 to 1598, changed the whole aspect of affairs; the celebrated Hyde Hochi, a Japanese general with considerable military talents, but whose only virtue was an intense patriotism, utterly destroyed Corean prosperity. The Coreans were ruthlessly plundered and massacred; no respect was paid to age or sex; the pottery manufacturers and silk weavers were carried off to Japan, where in quasi-slavery and enforced celibacy they were constrained to teach the Japanese their arts and knowledge. The Corean fishers were ousted by Japanese. The Corean port of Fusan was seized, and has for the last 300 years been a Japanese settlement. The Coreans were forced to give tribute to Japan, and this tribute was made as hateful as possible to the conquered people. Part of the tribute consisted of the human skins of Coreans, who were flayed alive for the purpose. Constant cries went from Corea to China for help. The Corean love and affection for China called forth the best qualities of the Chinese people—namely, generosity and a hatred for unremunerative wickedness. The Chinese had had their nobler vanity propitiated by the Coreans. The Coreans had adopted the Chinese written language and literature as their own; they had accepted and promulgated the Chinese criminal code; the Corean Court was modelled on that of China. The Coreans had even adopted the ancient Chinese dress. Slowly and prudently, with great deliberation, and choosing a propitious time, China came to Corea's assistance. Internal dissensions in Japan caused Hyde Hochi and his family to lose their influence. Japanese reinforcements were not sent in sufficient numbers to keep up the Japanese army of occupation. Encouraged by the aid of China, the Coreans rose on their oppressors, and massacred them with circumstances of great cruelty and barbarity. Though masters of the situation, the Chinese evinced great moderation. They sanctioned Corea still giving tribute to Japan, and allowed the Japanese to still retain Fusan as a settlement, and to keep the fishery privileges they had acquired along the Corean coast. The Chinese also withdrew their troops, and again left the Coreans in the enjoyment of internal self-government.

In the seventeenth century there was the struggle between the Manchus and Chinese for dominion in the East. The Coreans, mindful of the kindness of the Chinese, threw themselves with ardour on the side of their friends. The Manchus accordingly invaded and conquered Corea. By this time it was evident that the Manchus would be victorious; the Coreans accordingly submitted to them. The conquerors accepted the submission, left the Corean sovereign in possession of his throne, the people in possession of their own laws, and in the enjoyment of their own manners, customs, and dress; and only asked, on terms of peace, an annual tribute of small monetary value, and which was more than returned in generous presents; that the Coreans should still continue to use the Chinese almanac, and that the Coreans should not exercise the sovereign prerogative of coining money. (In the next century the Manchus waived enforcing this last clause.) The Manchus then withdrew their troops, and left the Coreans to enjoy liberty and autonomy as hitherto.

In A.D. 1644, the Manchu leader seated himself on the throne of China, and his successors with wisdom rare in conquerors have since governed China according to Chinese ideas, and have given Chinese more than an equal share in the administration of the united empire.

In 1873 Japan made a treaty with Corea; and ten years later Corea, yielding to China's influence, made treaties with various Western Powers. Appendices to these treaties state that Corea, though tributary to China, enjoys internal and external independence. China has loyally recognised these treaties, and has not since intervened in Corean affairs. In 1884 and 1885 two Corean nobles named Kim Ok Chun and Baku attempted a *coup d'etat*, and, after massacreing, with circumstances of extreme barbarity, their former friends and colleagues, attempted with the aid of the Japanese to murder the Queen. In this they did not succeed. One of the Queen's ladies was dressed in the Queen's robes, and paid for her loyalty with her life. Meanwhile the Queen escaped in disguise. The Chinese in Söul rushed to the palace to defend the Royal family, and, their blood being up, attacked the Japanese, and a dreadful slaughter ensued. The assassins Kim Ok Chun and Baku escaped and took refuge in Japan. Kim Ok Chun was inveigled to Shanghai in 1894 by a Corean named Hung, who shot him in Shanghai. Kim's dead body and the person of his slayer were delivered by the Chinese to the Corean Government, which foolishly (but in accordance with Corean law) tried the dead man and dismembered his body as a traitor. His slayer was neither rewarded nor punished. The event of 1884 caused considerable friction between China and Japan, but peace was maintained by means of a treaty which stipulated that in case either nation sent troops to Corea to quell disturbances it should in the first place give notice to the other party.

To understand so extraordinary a stipulation it is necessary to explain the condition of Corea. From time immemorial Corea has been governed in a very primitive manner, the only idea of the governing classes being to get as much as they could out of the people, and the only idea of the governed being to pay as little as possible to the Government. The land tax, which is the principal impost, is levied in the most irregular manner. There is no fixity about it. Each official is the judge as to how much each land cultivator should pay each year. The principle is supposed to be to collect the impost according to the ability of the farmer to pay and to the exigencies of the Government. This system naturally has led to the levy being at once unproductive and oppressive. The officials have far less power than the local nobles, consequently the nobles escape the land tax, and the richer a man is, and the more friends he has got, the easier it is for him to have his land tax lightly assessed, while the poor are badly oppressed. The only remedy is for the people to rise in insurrection. The consequence is that every spring, from time immemorial, there have been insurrections. Very bloodless affairs as a rule, and considering the numbers engaged these insurrections were far less dangerous than our game of football, or than the Corean game of stone-fighting, which takes place in winter just before the season for insurrections.

These insurrections, as a rule, end in the King cashiering a certain number of officials and appointing new ones; but sometimes this did not end the game, and the Chinese would be asked for help. In such cases the Chinese would send troops nominally to quell the insurrection, but really to act as mediators between the officials and people, and to compel the nobles to pay their fair share of the taxes, which, after all, are not very heavy, or rather would not be if evenly distributed.

This treaty of 1885 inferentially placed China and Japan on a similar footing towards Corea. After this treaty, I presume, if the King of Corea required troops he would be free to ask them of either power he chose, but neither power could concede the request without notifying the other.

From 1885 to 1893 everything went well; the prosperity of Corea was increasing by leaps and bounds; the government was gradually improving; the people were developing germs of a capacity for trade, and of habits of frugality. Practical schemes of railways, bridges, and improving the roads in the country were being seriously considered. The Customs revenue from January to the end of May, 1894, was the best on record. There had been capital stone-fights in winter, and now spring came on and there was to be a splendid game at insurrection. Unfortunately the game of insurrection seemed to be gone into with even too much ardour, and the King applied to China for help. China, the day she consented, notified Japan, and landed 2,000 men on the 10th June, as near as possible to the scene of the insurrection. Japan, under the pretence of strengthening the Legation guard, landed a larger force on the same day close to Söul, and at once marched it to Söul, and occupied the capital unopposed, except by protest of the Corean Government. Very soon Japan had something like 12,000 men in the country under the pretext of a Legation guard, and not only occupied the capital but also the treaty ports, especially Chemulpo. The Corean authorities said the insurrection was over, and asked both parties to withdraw their troops simultaneously. China assented, but Japan refused to comply.

On the 23rd July Japanese soldiers attacked and took the palace in Söul. The King ordered his troops not to return the Japanese fire, consequently there were but few casualties on the Japanese side. The King and Royal family were made prisoners by the Japanese and harshly treated, being confined to very narrow squalid apartments in the palace, while the principal buildings were filled with Japanese troops.

On the 25th July, without any declaration of war, four to seven of Japan's finest and fleetest war vessels attacked two rotten old Chinese tubs and one respectable Chinese gunboat of about half the size of the smallest Japanese man-of-war engaged, and of far less speed. The Japanese took one tub, sunk the other (allowing the crew to escape), and allowed the gunboat to slip through their fingers. They then went and sank, with a torpedo and numerous rounds of big guns, a British merchant vessel chartered to carry Chinese troops—it being a time of peace—which had anchored in obedience to the orders of the Japanese naval officer. The Japanese saved the master, mate, and one boatswain, but not only made no effort to save the troops and others but poured volley after volley from their machine guns into the drowning wretches, and fired, from the boat that had saved the mate, into a lifeboat into which the Chinese crew had managed to get.

Immediately on hearing the news the Chinese force tried to march southward; meanwhile more Japanese had arrived, and a force of from 8,000 to 14,000 on the 27th July attacked the rear guard of the retreating Chinese. Instead of following the Chinese up, the Japanese marched on thirty miles to the old Chinese camp, which they found deserted, but in which they found some guns and other objects which they brought to Söul as trophies.

The Chinese continued their retreat to about forty miles south, and then made a detour and marched unopposed to the north of Corea, where on the 16th August they joined a Chinese force which had crossed the Yaloo River.

On the 1st August Japan declared war against China. While peace was still supposed to prevail there was fighting. Since the declaration of war till now everything has been peaceful.

So far for Corean history It is needless to say that, since the occupation of Corea by the Japanese, trade has been killed. All hope of the amelioration of this country is at present gone. The Japanese have, it is true, forced the Coreans to adopt so-called reforms—such as, Coreans are to wear tight instead of loose sleeves; that widows may remarry; that men shall not marry before twenty (if the reform ever is operative it will increase the social evil); and that the primers used in the primary schools shall be printed by the Educational Board. (As there are neither educational board, primary schools, nor primers, this reform seems somewhat previous.) Salutary as these and other similar reforms may be, they are not a large return for the woes inflicted on the country by the invasion. On the other hand, on the whole the discipline of the Japanese army has been fairly well maintained, and the Japanese soldiers commit far fewer crimes and offences than one would have imagined, so that the condition of the Coreans is not quite as miserable as one would have expected.

The population of Corea is about 10,000,000. The country is fertile, and is said to be rich in minerals. The climate is healthy, the land is well watered, and it should be able to support its inhabitants in health, wealth, and happiness; but owing to the rapacity of its Japanese neighbours, and to its internal misgovernment, the people live in a state of dire poverty. The Japanese have injured Corea not only by their invasions but by their extortions. Then the coast fisheries in the south are monopolised by the Japanese, and the Japanese are the usurers of the country. They advance small sums of money on the farmers' crops to the improvident Coreans, and exact exorbitant interest. In Söul, Japanese seduce the people into vice by opening gambling dens, booths for the exhibition of pernographic photographs, and brothels. I presume the Coreans have their native social evils, but if so they are not obtruded on the public attention. The only prostitutes I have seen soliciting in the country are Japanese women.

The greatest curses of the country are the nobles and the retinue of the officials. The nobles in Corea are a hereditary class and very numerous, with excessive privileges, all of whom combine together to protect their order. None but nobles can become officials, and it is derogatory for a noble to engage in trade or handiwork. The consequence is the country is full of proud, poor men, whose only means of livelihood is plundering the plebeians. This they can do with impunity, as the officials dare not punish a noble, even if they wished to throw aside the prejudices of their caste and do justice, as such would bring upon them the enmity of the whole of their class.

The retinue of the officials throughout the country form a sort of trades union to uphold their perquisites and extortions, and any official who endeavours to put too strong a check on his retinue will have the retinues of all the officials of the kingdom against him. These men will not hesitate, by perjury, whispered falsehoods, and other means, in ruining any official against whom they have a grudge.

A fourth evil is the bad system of collecting the land tax, which I have above alluded to, and which leads to insurrections more or less dangerous every year.

A fifth evil is the badness and severity of the laws. This evil is to a certain extent mitigated by the fact that the law is seldom executed. The severe laws, for instance, against gambling would doubtless be carried out in Söul if a Corean opened a gambling den, but the Japanese, not being amenable to Corean laws, open gambling dens with impunity. The fact that the laws are inoperative through the dread of a foreign State, the privileges of the nobles, the rapacity of the followers of the magistrate, and the partiality and ignorance of the judges would in a country of complex civilization and wealth be intolerable; but in a simple, primitive country like Corea the evil, though far-reaching, is not obvious. Inexorable custom maintains its rule in this country, and it has not yet yielded to law. The Coreans are still governed by traditional custom; the reign of law has hardly begun. The Corean protects himself from the greater tyranny imposed upon him from without by a tyranny he voluntarily incurs, a tyranny from which he never dreams or wishes to free himself—the tyranny of the family, of the guild, and of the trade union. No one may make a hat under a certain price. The man who makes the hat must not make the strings to tie it. No one must build a house or perform any work under a certain price. It is, therefore, useless to advertise work to be given to the lowest tender—the tenders will all be the same. No porter may carry goods below a certain wage. If any member of a family, guild, or trade union is injured beyond what Corean custom considers proper—and Corean custom allows a great deal—his family, guild, or union will avenge his cause, and will wait long to do so. The Coreans have a proverb that if one wishes vengeance, put a stone in one's pocket, keep it there seven years, waiting an opportunity to throw it. If such does not occur in the seven years, turn the stone, and wait another seven years.

All men are to a great extent the creatures of circumstances, and the love of revenge in the Corean's breast is forced upon him by the absence of obtaining justice for wrongs done him, and the knowledge of this characteristic in his countrymen acts as a check on cruelty and oppression.

Another vice of the Coreans—improvidence—is the effect of the misgovernment and the cause of the stagnation and poverty of the country. A Corean plebeian has no motive for saving; any sign of wealth would only make him an object for extortion. The consequence is the Corean spends at once on eating, clothes, or drinking—specially the last—everything he earns. To-day is his own; he never thinks of the morrow. In other words, he finds it wisest to invest every cent he makes in his immediate enjoyment. If he tried to save for a rainy day the money would be taken from him. I had a Corean in to mow my lawn; it was a two-days' work, and I foolishly paid him his day's wages at the end of the first day. The second day he did not come. I sent for him and he replied, "Why should I work; I have enough to eat to-day and to-morrow; I will come when I have spent all my money."

Again, a Corean gentleman was speaking to me about the Christians. "Ah," he said, "the Christians are very bad." I asked him why. "They are very bad; they lend the Coreans money." "But there is nothing bad in that." "No, but you see they want to be repaid, and that is very bad." I told Monseigneur Mutel, the French Bishop, this story, and he told me that he very much discouraged the Christians lending money, and, further, made the Christians forego the debt when the interest had covered the principal and a fair margin for the accommodation.

One day the Bishop was asked for a loan of ten dollars. The Bishop refused, but said to the applicant, "I won't lend you anything, but I will propose to you a bargain by which we shall each gain five dollars. Do you agree to that?" "Yes," said the Corean hesitatingly. "Well, then, I will give you five dollars, by which I gain five dollars, for I shall only lose five dollars instead of ten, and you will gain five dollars, for you won't owe me anything."

That the Corean improvidence is entirely due to the evil conditions under which he lives is proved by the fact that if you take him out of those evil conditions he becomes a prudent and industrious man. Thus the Coreans who have crossed into the Russian province of Prœmersk are greatly prospering as farmers and artizans, and save money, much of which they remit to their relatives in Corea. Call it work, and the Corean groans over a walk of twenty miles; call it pleasure, and he will joyfully walk forty to see a stone-fight or procession, or for any bit of fun. But still there was a manifest improvement setting in as regards providence and industry from 1883 to 1894. In 1883 the trade of the country was carried on by barter. The Corean farmer took his sack of rice to market and swopped it for cloth or drink—specially drink; but by 1894 he began to save money for foreign luxuries, such as kerosene oil and other objects, and, instead of taking his sack to market himself and thus losing time, he was beginning to club with his neighbours and send his produce down by boat or wagon. The number of cargo boats on the rivers and of wagons on the roads was increasing rapidly. The roads were being improved; new and better houses were being erected in the towns and villages; silver and paper money were coming into use, and the ease with which they could be carried and concealed were inducing the people to save; whereas previously the heavy and bulky coins of spelter (about 9 lb. to one shilling) were not fitted either for carrying or storing. Gold dust, the currency among the nobles, was far too expensive an object for the plebeian to invest his savings in. The administration of the country was deplorable, and I should have thought it impossible to have been worse than it was in the beginning of 1894, but, on reading up accounts by various authors of the state of things previously existing, I discovered that there had been great amelioration. This amelioration, slow and almost imperceptible at first, was proceeding with accelerating speed, and until the Japanese invasion there were signs of the beginnings of better things. The police of Söul was well organised; the town was remarkably free from crime, and in no city in the world was order better maintained.

One vice of the Coreans—untruthfulness—he partly shares with all Asiatics; but partly it is the effect of oppression. Duplicity is always the refuge of the oppressed, and in them the vice has its palliations. Duplicity in the oppressor is the height of iniquity, and has no excuse.

I think I have pretty well gone through the list of Corean vices. I think I may now take a turn at his virtues, and the first of Corean virtues is politeness. It is a manly politeness, without ceremony or cringing. It is, I think, the exceedingly gentlemanly manners of the Coreans that, with the beautiful scenery and pleasant climate, make Corea so charming a place to live in, especially after China and Japan. It is almost impossible to convey an idea of the delightful politeness of the Coreans by description and anecdote. From His Majesty the King to the poorest Corean, every native has a grace and a tact in doing little acts of courtesy and in saying kind things. The street urchins greet one as one passes through the streets with smiles and a few words of English. The peasants in the country present one with bundles of wild flowers and ferns. (The Corean is passionately fond of flowers.) If there is a procession or sight, the Corean will lend an upper room in his house for strangers to see the show, and will not accept any remuneration. Once I went with my wife to see a procession, and we determined to take our place with the crowd of sightseers. Several Corean gentlemen came to me and asked me to allow my wife to join their families in the balconies they had engaged for them. Nothing could exceed the good nature and the politeness of the crowd. The men and women of the mob literally bubbled over with fun, and were playing all sorts of jokes on one another. It was a remarkably clean crowd for Asiatics, for the Corean man specially prides himself on the spotless purity and lustre of his white clothing. The women and children are in gay colours. In summer the children go without clothes, and are not as particular about their persons as they might be.

Again, the Corean is very generous; as long as he has a pound of rice he will give a meal to a poorer neighbour or even a stranger. It is Corean custom that any Corean may claim a gratuitous meal and a gratuitous night's lodging from any other Corean. Some of the poorer Coreans live a life of wandering, and the only expense they incur is for their clothes.

So poor and proud are the Coreans that when they come to Söul they hire fashionable clothes in which to swagger through the streets of the capital. The letting out of such clothes is a lucrative trade.

With such a habit of helping each other, it is not wonderful that the Coreans have very indistinct ideas of the difference between *meum* and *tuum*, and are apt not only to help others but also to help themselves in a way we Westerners, who are more alive than they to the rights of individual property, do not approve of. Any article without a visible owner is taken by the first comer. Thus, if one leaves one's house deserted or one's field uncultivated, the first person who comes by may take possession of it. Just after the taking of the palace, on the 23rd of July, 1894, a Corean came to me and said, "This is very bad; my family greatly fears and is going to run away." "Well," I said, "your family will come back." "Yes," he said, "but I fear someone else may come and take my house, for it is a Corean custom that anyone may take an empty house unless some living thing, like a dog or a cat, is left in it. I have not a dog or a cat, so I intend to leave my wife's mother in the house." And then, after a pause, "She is an old woman and may die before we come back."

A friend of mine had a stable in his compound, some way from his house, which he did not often visit, as he did not keep horses. His story is best told in his own words. He is an Irishman, by-the-by. "I went to my stable and found it was not there." The Coreans, seeing the stable unoccupied, had helped themselves, first to the tiles of the roof, then to the rafters and bricks from the walls, and lastly to the tiles of the floor, until all vestige of that stable had disappeared—"*Evasit erupit et non est inventus.*"

The King has three palaces in Söul, which I will call A, B, and C. Early this spring His Majesty determined to repair palace C; and as palace A was not occupied at the moment, he determined to get the tiles and beams he wanted for palace C by partly pulling down palace A. The King's officers having helped themselves to what the King and they wanted, the people had their turn, and, without the least opposition or question, openly helped themselves to the remains of the palace outbuildings, and in a few weeks they had as completely disappeared as my friend's stable. Yet that the Coreans are not a dishonest people is proved by the fact that packages could, before the Japanese invasion of 1894, be sent from one end of the country to the other in charge of the ordinary street porter without the slightest danger of anything being stolen. It was a common thing for the shopkeeper, after laying out his wares of fruit, fish, tobacco, sweets, vegetables, &c., on a stall with a tray beside it to receive money, to leave his stall for the rest of the day. The passers-by would help themselves to the articles wished, and throw the price on to the open tray, money and goods being left unguarded till the vendor returned and took his property. The curious thing was that round these stalls one always saw crowds of urchins looking with longing eyes on the—to them—tempting sweets, unguarded save by Corean custom.

Another amiable quality of the Corean is his fondness for manly sports, the greatest of which is stone-fights. A Corean gentleman thus described the game to me:—"In the winter the people have nothing to do, so the strong and brave men of all the towns of Corea come to Söul to play and fight. The strong men of one town fight the strong men of another town. I go on the wall of the city to look. People must not fight in the city. I keep far away. Then they throw stones at each other, and beat each other with sticks. If they kill each other it does not matter."

I have not seen a stone-fight, but have seen crowds going to see one. The broad main street was a mass of white-garbed Coreans. I was new in the country and my daughter was with me, and so I turned back. Had I known then how polite a Corean mob is, I would have gone on and seen the fun.

The Corean boys wrestle, box, and fight each other for pure fun; take standing jumps, and swing. Swinging is the delight of the Coreans. In spring, just before the farmwork begins, mighty swings are put up, paid for by the rates, in the roads by the villages and in the streets in the towns, and on these swings boys and youths exercise themselves from daylight to dusk. The girls do not swing, but play at see-saw.

Other notable games of the Coreans are flying kites and playing quoits.

Though the Coreans are not Buddhists, and though owing to a rebellion by a Buddhist priest many years ago no Buddhist priest is allowed in the city of Söul, yet the birthday of Saky-a-mouni Gautama is kept as a children's festival. Early in May the streets are full of toys for the little ones, and on the day itself the town is given up to children wearing bright new clothes and enjoying themselves. The sight in the big main street, with its throngs of happy children in their bright clothes, each child with its hands full of toys, accompanied by their fathers and grandfathers in snowy clean white raiments, showing in keen contrast with the sombre grey tint of the nearest houses, and the dark-green of the fantastically shaped mountains in the distance, seems a glimpse at fairyland, and would have delighted the heart of Hans Andersen.

Shortly after the children's day comes the ladies' day, when ladies are allowed to go freely about the streets and visit their friends. On this day men, to a certain extent, stay at home, and no one becomes tipsy. As a rule, ladies do not go about in the daytime; they go about and take their exercise at night. At about 8 o'clock in the evening the great bell of Söul—it is one of the largest bells in the world—is pealed, the city gates are closed, and only men who have business remain out of doors.

The Corean is a great lover of scenery. In the spring it is the fashion to have picnic parties to beautiful spots in the neighbourhood of Söul, and in every direction one goes from Söul one finds charming and beautiful spots, in which are erected pretty little pavilions, in which one can sit sheltered from the sun and enjoy beautiful views.

For evening amusements one has dinners, music, and dancing girls. The Corean music is pleasant, but rather sad and monotonous. The Corean dancing is slow, and rather posturing than dancing; it is highly decorous. The clothes of the dancers are not graceful; the dancing girls look rather like sacks. Every portion of the form, from neck to feet, is concealed. The dancing girls are usually slaves; they are well treated, and very modest in their behaviour. The indecent games of the Japanese are not played in Corea.

In conclusion, I would say, in my opinion, there is in Corea a hopeful field for missionary effort. The Church of Rome has been many years in the field, and numbers some 24,000 converts.

There are Protestant Christians in the North, and all over the country devoted Nonconformist missionaries are endeavouring to elevate this people by announcing Christian truths and inculcating Christian morality. To these heroic workers, though I do not belong to their sect, and do not concur in all their methods, I wish with all my heart all success.

With one mission I am in most thorough accord and sympathy, and that is the British Episcopal Mission, of which Bishop Corfe is the head. This mission is mainly supported by the officers and men of Her Majesty's navy. The mission comprises the Bishop and four clergymen, 30 feet and a few inches to spare of muscular christianity, who combine to a very unusual extent intense zeal and self-devotion with large-minded prudence, toleration, and common sense.

There are attached to the mission two men's hospitals and one female hospital, in charge of two medical men and one lady doctor, with a staff of trained European nurses.

There are also several schools for children, and a printing press.

The mission publishes detailed accounts of its receipts and expenditure, and invites inspection. Captain Castle, R.N., has inspected the hospitals and published the result.

It is perfectly wonderful how in a few short years the members of the mission have gained the affection and respect of the Corean people. The lady doctor is known all over Söul and its environs as "*The* Lady," and her help is eagerly asked for, and her pony eagerly looked out for by the villagers. One missionary is known everywhere as "Dear old W." ("Dear old W." is about twenty-seven), and another as "His Excellency, the great man." Of course I am translating the Corean terms. The last title struck me as peculiar, so I asked a Corean, "Why do you Coreans always call Mr. T. 'His Excellency, the great man'?" "Oh," he replied, "Mr. T. a very good man; he is more strong than the devil." I was still in the dark, and he said, "Mr. T. buy one Corean house; that house have plenty strong devil. No man can live that house, but every man go and give that devil plenty thing, burn paper money, put food on the stone. Mr. T. go that house, no give that devil nothing; then that devil very angry, make Mr. T.'s servant sick. Mr. T. no give that devil nothing; that servant get well. Mr. T. very good man, more strong than devil." "But what would have happened if Mr. T.'s servant had not got well?" "At first that devil did not know who more strong, he or Mr. T., so first he try hurt Mr. T.'s servant. If that servant die, then that devil fight Mr. T.; but as that servant get well the devil knew Mr. T. very strong, and so fear to fight him."

All Coreans are fearfully superstitious; their lives are spent propitiating evil spirits, and their substance on male and female exorcisers. Blind people are supposed to be the most skilled in the art of exorcism. The Coreans spend their nights in terror of immaterial evil spirits, and their days in terror of the more substantial Japanese. Woe betide the Corean who attempts to resist Japanese oppression. The insulted or injured Corean has no redress. I do not know of a single instance in which a Japanese has been punished by his officials for ill-treating a Corean. In every criminal and civil case the Japanese court always decides in favour of the Japanese. The hatred of the Corean for the Japanese is not therefore to be wondered at, nor is it to be wondered at that a Japanese should occasionally be murdered by them.

That the Coreans, under all the adverse circumstances, should retain their gaiety, kindness of heart, and charming politeness is to my mind a sign that they are worthy of the benevolent efforts of the Episcopal Mission to raise them in the moral scale, and free them from the tyranny of superstition.

I am not without hope, when the real facts about Corea are known, that the Coreans may be freed from the other evils that oppress them—to wit, the tyranny of the Japanese and the misgovernment of the country.

NOTE.—Conduct of Japanese to Coreans: This is what Captain Goold Adams says (Corean Repository, vol. i, No. 3, page 238):—

"Our crew -Japanese—seeing that they had missed the channel, not knowing where to find it, and being full of resources, at once boarded the nearest junk, and belaboured the wretched Coreans in the most merciless way with boat-stretchers until they forced them to send one of their number to show us the way. I understand that this is the manner in which the Coreans are always treated by the Japanese. I would willingly have foregone every chance of ever getting to Söul just to have seen the Coreans throw those little wretches overboard, which they might easily have done had it not been for the certainty of being murdered on their arrival at Chemulpo, whither their junk was bound."

II.—NOTES OF TRAVELS IN COREA.

By the Rev. J. S. GALE, Wönsan, Corea.

Early in March, 1889, I took one pony and left Söul for an indefinite point in Whangha province. With me were two servants, who proved to be very useless and annoying. I rid myself of them as soon as possible, obtained others in the country, and have never had such ill-luck in my domestic affairs since.

On leaving the capital, the first thing that caught my attention was a dead body lying by the roadside, frozen stiff. People dying on the road are buried by those of the district within a stated time after being found. The people of the district, I learned, were responsible for all the requirements of the road, such as when bridges are to be put up or taken down, roads repaired or sprinkled with red earth for the passing of some official. The magistrate orders a head man to see to it, and he appoints a day when the people of the village begin the work.

In March the roads are at about their best, bridges standing and everything frozen up. The bridge question is a very serious matter in travelling in Corea. In the 6th moon they are pulled up by official order, and are only replaced at about the beginning of the 9th moon. During this bridgeless interval, travelling is very arduous, not to say dangerous. The rainy season, by land-slides and swift torrents, makes the roads all but impassable. On a single journey from Wönsan (Yuensan) to Söul I counted more than half-a-dozen land-slides that would have been sufficient to bury up one's small caravan. The torrents, too, are numberless. Once or twice I was thrown into the swift current, and the ponies with their packs on had very great difficulty in fording the streams at all.

The bridges in Corea are made of uprights placed at intervals of eight feet. The smaller ones are covered with pine branches and earth, the larger ones with timbers. The famous bridge of Corea is that entering Hamheung, the capital of Ham Kyung, from the south. It is said to be 5 *li* long, but timing it I found that I crossed it in about four minutes at an ordinary walk.

To return to my journey, I saw *miryuk* (stone images) on the rocks of P'achoo, some 60 *li* from Söul. They face south, and are said to have been placed there in the last dynasty in order to protect Songto against the increasing influence of Han Yung (Söul). The inn quarters along the way proved to be very uncomfortable, the *kang* being heated desperately in spots. The natives whom I had taken with me, and who had often to share my room, seemed to enjoy hugely frying themselves over these hot fires. I have never yet learned to take kindly to Corean floors. The food on this first trip, too, seemed very barbarous, but I have since learned to like rice, soy, and *kimch'i* much.

These are the three staple articles of food. With the exception of dried fish (principally pollack from the far north) scarcely any meat is eaten by the common people. In seasons of cattle plague they feast on the victims, but otherwise beef is not common. Dog flesh is used, especially during the three *Pok* days of the 6th and 7th moons.

Their ordinary rice dishes are only partially boiled, without salt, the *kimch'i* (radish or cabbage pickle) supplying the seasoning. The best *kimch'i* is prepared from cabbage placed in layers with fish, pine nuts, chillies, &c., between, and all pickled down and left to stand for a time. *Kimch'i* has a very unpleasant odour to a new-comer, but it is one of their best dishes.

Soy, of course, they prepare from beans. These are boiled and pounded up in a wooden mortar, rolled into balls and tied to the ceiling of the living room, affording a very disagreeable atmosphere to the place. In spring they are put into a jar of water with a little salt, and left for a month or so until fermentation begins. The water is then drained off, boiled, and the soy is ready for use.

To return to the journey, Songto proved to be an interesting old city. The remains of the ancient palace that fell about 1392 are still to be found. Anything like modern life or activity, however, are as foreign to the people as to the ruins of the palace. The people were hospitable, and treated me to the luxuries of the place, giving me dried persimmons, dates, and pears. As on all subsequent trips, I found the natives well disposed, though uncouth in behaviour, as they are in the other details of life.

From Songto I went directly west through Hăchoo, the capital of Whanghă province. Hăchoo is also a tumble-down place, with little that is interesting about it. Continuing the journey I reached at last a farming hamlet in the district of Changyun; and, after paying my respects to the magistrate, I went out to live with a Mr. An, a farmer of some means, who had a tiled house in a picturesque valley a mile and a-half from the sea-shore. I remained here some three months, and found life quiet and pleasant.

There were many callers, and among them some very interesting people. One farmer, Mr. I, living a mile to the west, came frequently. On one call at his place he showed me a map of the world that was quite well done for an outline. It had been brought from China by some of the fishing parties who cross to this coast for sea-slugs every spring. Mr. An owned his land, but Mr. I worked his for half the crop, the owner living in Söul. This is a common way of letting out land in Corea. The owner supplies the seed, while the tenant works the land, each receiving half the crop. Small patches of land are owned and worked by independent farmers, it is true, for which they possess an unofficial deed signed by the writer and a witness or two, but the best paddy-flats are all in the hands of wealthy owners.

Toward the end of April the work in the fields began. The Coreans have two kinds of ploughs—one with a blunted end that runs the land into drills, and the other with a single mould-board that turns over a furrow very nicely. With these single mould-board ploughs they break up the paddy-fields, then turn on the water, and rake them with a huge sort of comb-shaped harrow. Cattle—never horses—are used for breaking up the fields. Horses are kept for the roads only.

Paddy-fields are divided, where possible, into what is called a "day's ploughing." For one *mal's* (ten *catties* or 1·63 gallons) sowing, $15·00 is an ordinary price. A yield of 40 to 1 is considered good. The best paddy-fields are never manured; in fact, to manure them is to spoil the crop. The stubble and roots of the former year ploughed under are sufficient. The soil of the best fields is ashy coloured, and very sticky on the slightest rain. Second-rate fields are scattered over with oak leaves which are at once ploughed under, but even the poorest is expected to yield twenty-fold.

Formerly a red chaffed paddy was much grown in Corea, but white chaffed now is the commonest variety. There is also a great deal of glutinous rice, which is used in making a kind of bread and fermented liquors.

In seeding, a corner of the field is sown thicker; when up six inches or so it is cut into clumps, and transplanted at regular intervals. Except in the far north, paddy-fields are found everywhere. The flats north of Hăchoo, in Whanghă, and the region about Mankyung, in Chulla, which the Tonghaks have recently made famous, are the noted paddy districts.

As for other grains, I found Barbadoes millet (*Sorghum vulgare*, with red grain), and panicled millet (grain of a grey colour). These are sown on damp lowlands in drills, and the yield is about 200 to 1. The distribution of these grains is general, as I have found them on the Chinese border and also at Fusan in the south. Sorghum is used in the preparation of a red sticky candy. It is also boiled and eaten in place of rice. Panicled millet grain is used as a boiled dish by the poor, especially in the north. These crops do not alternate with others, and require but little fertiliser.

Common millet with a yellow grain is sown in drills on dry land, with beans, &c., between. One day's ploughing yields some twenty bags, bringing a land price of $60·00. Common millet crops alternate with wheat. The wheat crop, requiring much manure, makes a good preparation for a crop of millet the following year. The poorer classes use much common millet. On a journey from Chăsung, in the far north of P'yungyang, to Hamheung, in 1891, I found boiled millet the ordinary dish. Their way of preparing it makes it most uninteresting. To me it seemed like eating dry sawdust, and I was glad to alternate it occasionally with oats and potatoes. A poor kind of fermented drink is made from common millet.

Wheat is not popular because of its small yield and limited use, one day's ploughing yielding only three or four bags. It must be well manured. This manure is prepared by catching all the urine about the place—a most offensive trough being found before each guest-room door in the country. A heap of dried grass, earth, and rubbish is raked up before the door. When it has accumulated to some six or eight feet in height the contents of the trough is poured over it; it is then set fire to, and the charred mass and ashes are used as fertiliser. This is the common practice in the central part and far north. In the south, cesspools are formed among the fields, and from these liquid manure is carried. Manure is all hand-mixed, and is dropped along the drills in spring; the labourer by one foot making a hole to receive it, and by the other covering up the manure. Wheat is also sown in raised drills with beans, &c., between; it is one of the earlier crops, and is often followed by buckwheat the same season. Wheat is the great staple for the preparation of spirit, both distilled and fermented, sweetmeats, cakes, &c., but is the least useful of all their grains.

Buckwheat—grown much in mountain valleys—is used in the preparation of vermicelli (*kooksoo*), the most popular dish in Corea.

Beans are grown in large quantities, planted between the drills of some other grain, as millet, wheat, &c. Used as feed for horses and cattle, they are always boiled, and fed in a trough of water. The quantity of water is so large in proportion to the solid material that the animals seem almost to drown before getting at the beans in the bottom of the trough. This bean broth serves as meat and drink, as ponies are never allowed to touch cold water.

Barley is also common, especially in the south. One variety is sown in the autumn in hollow drills, well manured. It is used as a safeguard against famine, and as feed for beasts. The people use it only when rice, millet, and other more acceptable grains have given out.

Oats grow in the far north, where other grains would prove a failure. On the way from Hooch'ang to Hamheung I found boiled oats a common dish. The people always apologised for offering such poor fare as oats.

Glutinous millet also grows, and lentils, from which a clear sort of jelly paste is made (*mook*).

This stay in the country was my first view of oriental farming life. The small percentage of the population that worked was the surprise to me. I seldom failed to go for a walk in the afternoon of each day, and all the young fellows of the village seemed perfectly free to go along. A few toil-worn coolies did all the work of the district. Mr. An (a man of fifty-five years), his son (a man of thirty-four), and other able-bodied members of the family did nothing, absolutely nothing, all day. He had two servants, who lived in small huts before his door, and these, with a boy or two, worked in the fields. For the inner quarters there was also a woman slave, for whom he had paid something like thirty dollars. Slaves range in price according to their ancestry. One who has had a good line of slave forefathers is less likely to run away, and so will command a higher price. Slavery exists everywhere; but the possibility of the slaves running away and hiding in the mountains makes the system less rigorous than it would otherwise be.

As for pastime, the young men of the village seemed to have two varieties:—One in making a good quality of straw mat, at which they would work a week and then sell for about 50 cents; and the other was *patook*, a kind of draughts. They would play hour after hour without money in these cases, though gambling is exceedingly common throughout Corea.

There was plenty of game. I could see deer feeding daily a quarter of a mile back from my room, while pheasants swarmed everywhere. They made several efforts to get a shot at the deer, one villager owning an old rusty gun that was worked with a long rope fuse. The way they managed it was to give this gun to some wretched coolie boy or other, telling him to bring down that deer, while the gentlemen ranged themselves under a tree or in some cool place to look on. The boy knew nothing whatever of guns or deer, and consequently we never had fresh venison.

A few miles from where I lived, in a district called Chăryung, is the largest iron works in Corea, and yet very small according to our notions of things, and very rude. I cannot give any idea of the yearly output, as the natives seem to know so little of it themselves. They use a huge bellows to assist in the melting. The pig iron is then taken and worked up by blacksmiths.

There is considerable fishing along the coasts not only of Whanghă but everywhere else in Corea. The favourite method of taking them is by a hanging-net. Poles thirty feet long and more stand on end, three or four feet projecting above the water. Stones with ropes fastened round the pole are slipped down to the lower end, a sufficient number of them serving to keep the pole in place even in the roughest weather. They are put up in the form of a square, and are held together and to the shore by strong cables of *ch'eulk* (a creeper, the *Pueraria Thunbergiana*). Reed nets are hung about these poles, and are visited twice a day—in early morning and in evening. These *sal* or hanging-nets are usually put up in the twelfth moon in readiness for herring, which they ruthlessly take at the spawning season. Some are then pulled up; others, again, hang all summer, making small catches of cod, salmon, thornback, flounder, and the favourite fish of Japan, the *tai* or *Seranus marginalis*. The sea is very poorly worked, I am sure, and so the Japanese are making a good thing of Corean fishing.

The commonest fish in Corea is the pollack, taken on the north-east coast of Ham Kyung, and then dried and sent over the country in all directions. Bales of it are stacked up in the ports. It is sold everywhere in Söul, and really turns out to be the most useful fish product of the country. The pollack is a variety of the cod, smaller, and only found in northern waters. The limit of this fishing district is very small, principally about Kilchoo and Myungchun, and yet it supplies all the country, and, I believe, is also shipped to Japan.

To return to Whanghă. On an island half-a-mile from the shore, Mr. An had a cousin of the same name who had an interest in fishing, so I proposed a trip across. We went down to the beach and kindled a fire, which was a signal for the boat at the island to push out for us. It came, and we were sculled over. The island was less than a mile in circumference, and on it were fourteen houses, the chief man being Mr. An. I went out with his party in the evening and saw them work the sal nets. It was 2nd June, past the best season, I was told. They took a few common ray and a lot of globe fish, a creature that puffs itself up like a pouter pigeon. Its flesh is said to be poisonous, though the oil is valuable for lighting. I was treated to some of the ray eaten raw with vinegar and soy. The fish is first washed in *makoli*, a cheap fermented liquor, which removes any unpleasant odour, and then it is served—a very acceptable dish.

From Mr. An's island I took a small junk for Chemulpo. It was about 20 feet long and 7 wide, with one mast. Junks differ from river scows in that they draw more water, and are built more firmly. The sides are fastened by a sort of wooden pinning across the corners. The rudder, which is long, runs under the boat at an angle of 45 degrees to the deck line, and so serves as a centre-board as well as rudder. The first announcement of shallow water is seeing this pulled up a notch or two. I remained six days on this junk. There were altogether ten Coreans; seven were passengers, friends of mine, the remaining three forming the crew. We all ate rice washed in sea water, which gave it a most peculiar flavour.

There were islands at which we tied up in the evenings. At one island called Teungsan, the *Chumsa*, or officer in charge, took me ashore and treated me to a dish of *ponepe* fish (*Octopus vulgaris*). This, too, I found a very palatable preparation. Between waiting for tides, winds, and fair weather it took us six days to get to Chemulpo. The junk was full of vermin, and the bilge water seemed to grow immensely deep at times. I was glad to get ashore, though I felt sorry at leaving the old skipper who had brought us through safely.

The next journey was in the following winter from Fusan inland to Tăkoo, the capital of Kyung Sang province. I left Fusan on a bright sunny day in December, 1889. There was no snow, and the roads being frozen were very smooth where rocks did not interfere. Little of any interest was seen on the first part of the journey. The first evening out one of the scows that ferried me across a tributary of the Naktong had in it a number of bulls loaded with rice. One took fright and bounded into the water, carrying a small boy on the end of its halter. The other bulls followed suit, and rice and everything disappeared under the water. There was no loss of life, but the little lad's clothes were soon frozen stiff, and he was carried off to a Corean hut to thaw out.

The Naktong is a long useful river, with carrying trade from the whole southern province, the richest of the eight.

Boats on the river are very different from those on the sea, being flat scows with a draught of only a few inches. They are dragged up with tow-lines, and then let down with the current. Flat boats run as far as Sangchoo, on the Naktong. The south branch of the Han is navigable as far as Chungsung, only 100 *li* or so from the east coast, the north branch to Nangch'un. The Fătong, in P'yungyang, has three branches. The south branch is navigable to Koksan, the middle to Yangtuk, the north to Tukch'un; while the Yaloo, the great river of the north, has a carrying trade from the foot of the Ever White Mountains.

I continued my southern trip to Tăkoo, and reached it in about four days, it being 270 *li* from Fusan. I saw this country in the bleak season of the year, which perhaps accounted for my lack of interest in it generally. It seemed very poor; wretched huts, rougher people, worse fare than I had found up north.

Tăkoo is situated on a plain some five miles across, built mostly of thatched huts, having a wall 7 *li* in circumference. The governor, before whom I was brought with my passport, was a very pleasant gentleman, Kim Myung Chin. He was poisoned the following summer by some parties whom he had offended through a decision of his regarding a grave site. They put arsenic in a water-melon, and so made away with his life.

There is in Tăkoo a paper manufactory. The best Corean paper is made of the inner bark of the *Tak* tree, a variety of mulberry (*Broussonetia papyrifera*). The best noted spot, however, for the manufacture of paper is not Tăkoo, but Ansung, in Kyungkein province.

After a few days, barren of any particular interest, I took two ponies and started east for Kyungchoo, which was the old capital of Silla, and a very famous city in ancient days. There were no mountains to cross, and three days' easy journeying took me to within sight of its walls. I have heard that the people here were dangerous to travel among, but found them only harmlessly rough. The walls of Kyungchoo are built of rude stones, and form a square. The situation of the place, at the foot of the hills which extend to the east, is very picturesque, especially so by way of contrast with Tăkoo. A famous bell hangs outside the south gate, and near this spot the best crystal for spectacles is obtained.

From Kyungchoo I rode south along a valley through Unyang and Tongnă. I took other trips into different parts the next spring, but I am not in love with the lazy poverty-stricken south.

I found all through that roads were left to take care of themselves. Were it not for the blessing of some passing official, when the people are compelled to turn out and do something in the way of repairing, I am afraid there would not be even the means of communication that there are now. Stones are never picked off. Streams of water naturally take to the hollows cut by the ponies, and it is washed out and tumbled in until the worst possible results in road development are brought about.

As for means of transport, officers have what are called *yuk* or post stables usually at intervals of 10 *li*. Here horses are kept.

Where the stables are far apart, or where there are no horses on hand, the common people, one and all, are pressed into service. I have seen them beaten soundly for raising objections to shouldering a bundle. At night, too, when torches are required, they must turn out. The natives have learned from experience to have torch straw ready; and while they never fail to grumble and speak of it as though it were a matter unheard of—this turning out at night—they soon fall in and light the official to his destination.

In the south all the common grains are found. Hemp also is grown widely, and is used in the manufacture of cloth for mourners' dresses, &c. The straw is bound into sheaves, placed in a covered pit, and steam-cooked from beneath. It is then washed in the nearest stream, stripped of its fibre, boiled again, washed, and twisted into threads. Other plants furnish fibre for grass cloth, but are less common than hemp.

Cotton also grows. One day's ploughing is said to yield 150 *geun*, or *catties*. It is planted on strong ground, and fertilised from old walls, fireplaces, &c. Now that so much is imported in the way of piece goods, the growing of cotton is on the decrease.

Tobacco, too, is found everywhere. Coreans have a saying that one pipe-bowl of tobacco-seed is sufficient for a day's ploughing. It must be transplanted, highly manured from old walls—the best fertiliser, they say. The terminal bud is nipped off, so as to give the leaves more opportunity to grow. The leaves are stripped off at the proper season, and wound by the stems into long strings of straw rope. These are dried gradually and pressed.

"True" *Sesamum* is another useful plant. The seeds ground up and salted serve as a kind of butter. The oil pressed from it is used in all kinds of cooking, while the soot from burning oil makes ink.

Water *Sesamum* is planted along the borders of fields. The oil from this is used in the preparation of waterproofs.

The oil from the castor-bean, also common, serves for light in place of candles, for medicine, and as a lubricator.

There are, besides, fields of gourds, melons, cucumbers, chillies, egg-plants, &c.

My next long trip was begun in February, 1891. With a foreign companion and two Coreans—one a gentleman who spoke Chinese, and the other a cook—we started on foot for Euichoo. After leaving Songto less than a mile the road divides—one going to Hăchoo, the other to P'yungyang. We took the P'yungyang branch, and in five days were in the boat-shaped city. They say it was originally laid out thus, for which reason no one is allowed to dig for water inside of the walls, as that would be cutting through the bottom and sinking the ship. There is some life in P'yungyang. People are noisy, and are inclined to be unpleasant in their treatment of a stranger, but, considering the fact that we must look ridiculous to them, they behaved very well. There are no large manufactures; what little there is seems to be done in small one-roomed shops.

We passed through some mining districts along the way, principally gold. It is the rudest kind of placer-mining. We stopped to exploit several, and saw their methods of work. A heap of earth shovelled out, a pool of water, and a pan is all that is required. The miner tips his pan back and forth, washing round and round, dropping the earth gradually, leaving at last a particle or two of gold in the bottom of the pan. I learned that the amount they each wash out every day is little above ordinary coolie wages—600 *cash* or so.

None of the unofficial classes are allowed to work mines independently, and this perhaps dampens the ordinary digger's ardour. One official, I Yong Ik, has charge of gold-mining in the four northern provinces, to which it is chiefly limited. The best gold is found in Ch'ungsan, in Whanghă.

We found copper-mining near the north of P'yungyang. There is a small village some distance beyond Changchin, where there are smelting furnaces. The rough metal is taken from here to P'yungyang and minted into *cash;* but the output is something that Coreans are very silent about. I find it next to impossible to know definitely the amounts obtained from any of their mines.

There are also lead and coal—of course not worked. Coreans have a superstitious regard for the hills, which prevents their ever working any of them. Only the hollows are worked, and that very poorly, as, in the case of gold, they go washing the same earth over and over again.

Continuing our journey, we passed through Anchoo, a very pretty town, 180 *li* north of P'yungyang. It derives some importance from being at the junction of three roads—one to Wönsan, one to Euichoo, and one to P'yungyang. Such noisy crowds, however, in this place clamoured after us that we were glad to get away.

A few days later and we had completed our 1,050 *li*, and were in Euichoo. Euichoo is a more enlightened town than those inland, and so we fared well and proved less interesting to the natives. The place shows signs of having once been prosperous. The opening of the ports has doubtless ruined Euichoo, cutting trade and carrying the population to Wönsan and Chemulpo. There are still some efforts at business with China. Guilds and pawnshops yet remain as signs of commercial activity. The guilds have but few rules or regulations. Anyone of the same social scale may join by depositing so much. Stock, of course, goes up or down according to the times. Pawnshops also are interesting. Half the value of the object deposited may be drawn. The rates are at about 10 per cent. per month until redeemed. Pawnshops may be opened by private parties, without any permit from the Government.

In Euichoo there is quite a large establishment for pressing beans. The rollers were drawn by mules, giving the place quite a business-like air.

On 30th March, 1891, we crossed the Yaloo, and took carts for Mukden. The roads were very rough in places, but the life and activity of China was delightful after the comatose state of Corea. The inns we found disagreeable from smoke, and the food, full of grease and oils of various kinds, was execrable. A Corean just across the border, whom I met dressed out in Chinese clothes, remarked that there was freedom, that a man could work, and for that reason he liked it; but, he added, "The food! dirty is no name for it" (*mar anis*).

The second day we passed the imposing peak of Keumsuk San (Goldstone Mountain) to the right, and at noon stopped at Pong Whang Sung. A town like this seemed a veritable resurrection from the dead after Corea. The streets were thronged with busy people, carts passing to and fro, soldiers moving about. We had tiffin here and rode on. Not till within sight of Liaoyang did we reach the plains. This was the fifth day from Euichoo. We just skirted the walls of the city and pushed on for Mukden.

After a few days spent here we engaged carts for Teunghwasung, which lies in a line almost directly east of Mukden. We moved on for five days, the roads being heavy with mud, and crossed here and there by difficult streams to ford. There was still (15th April) much snow, and several times we found it exceedingly cold.

Teunghwasung is a lonely place, surrounded on all sides by mountains. We stayed a day or two, and then continued our carts for 160 *li*, bringing us to within 30 *li* of the Yaloo. In Teunghwasung we were told of a party of Englishmen who had passed through a year or two before, and how they had twenty horses and guns innumerable. Seeing so little gunpowder in our caravan, they shook their heads, as if to say, "England is not as powerful as she was a year or two ago."

The last part of the journey proved to be most interesting. In the inns they gave us corn bread and boiled cornmeal, but no rice. Before entering the forest, which extends along the way for four or five miles, we saw coal-pits being worked on many of the hills, which proved to me that Chinese do not regard their hills with the fear and reverence that the Coreans do. Shortly before entering the forest we passed a theatrical performance, the first of the kind I had ever seen. There was a rude stage, and people acting the parts. An immense crowd of spectators gathered and lined one side of the hill. Where so many people had come from in that desolate region seemed very strange.

The forest part proved interesting from the fact that we lost our way, and had great difficulty in finding it again. The road is little travelled, and there being woodcutters' paths branching off here and there makes it very uncertain. We found ash, oak, birch, and other hard woods; and right in the middle of the thickest part was a hut marking the terminus of the cart-way. Here we took leave of our Chinese muleteer — who had to leave us—to walk and carry our baggage as best we could the remaining 30 *li* to the Yaloo.

We passed through shaded cañons, where we found the ice still seven and eight feet thick (19th April). A Corean of the party fell into one of the many ice-pools that we crossed, and received a severe wetting. Later on we found a Chinese party on their way to Ma-er-shan. They were ascending a ridge when their pony rolled off with all their kitchen utensils on his back. They looked a very miserable party, and we, with our loads, seemed powerless to help them.

When we had gone some 15 *li* we found a Corean hut, and decided to remain there for the night. They fed us once more on rice and *kimch'i*—delightful fare after the lard and corn-bread of China. The old master was very uncommunicative. I asked why he had left Corea to live over on the China side, but he declined to say more than that there were many others moving across also. They seemed to get along well with the natives, and look quite prosperous. I have found the Coreans everywhere kindly disposed to the Chinese. They give them a much higher place in their hearts than they do Japanese or any other people. The Chinese valleys are well wooded, the land is fertile, and people are able to keep any little that they make; so I can quite understand the inducement that there would be to the ordinary Corean farmer to move across the Yaloo.

Next morning we continued our journey, and at about four miles from the Yaloo found the road branching off to Ma-er-shan. We kept straight east, and came on a lumber camp on the Yaloo. They were a rough-looking lot of fellows, hewing timber. Some of the logs were three and four feet in diameter; they had been floated down from some place further north, and were now being prepared for shipping inland.

These lumber rascals wanted $8·00 to put us across the river, and when we showed our Chinese passports they laughed and said there was no law where they lived, and, consequently, they were not obliged to conform to passport conventionalities. Our Corean interpreter, who was a very good fellow, took charge and got us across at last for the modest sum of 25 cents.

We found ourselves once more in a mountainous region overlooking many bends of the Yaloo, a part of the district of Chăsung, about 41° 30′ N.L. There was a neat path winding over the hills, and my boy seasoned the way with bunches of wild onions that grow everywhere in the fields in spring. They seemed so fresh and acceptable in a land of barrenness. Ten miles more took us to the magistrate's village, Chăsung, a miserable slab-roofed settlement where they seemed to have nothing in the world to eat but yellow millet. The ferry-boat on the Chăsung, a tributary of the Yaloo, had floated away, and there was no means of getting across. After waiting in vain for a day or two, we made the ponies ford it, and crossed ourselves further up, which we reached by climbing the hills.

All along the way here were traps for tigers. There are undoubtedly many of these animals, and the helpless people live in great terror of them.

Notwithstanding the primitive state of things in general, they have schools here as elsewhere in Corea. One little lad whom I met was reading Mencius.

Our baggage here proved a very great inconvenience. There were two large pony loads, or about enough for six men, and we transported it in all kinds of ways—sometimes on a skid, once by cart, of which there are many in the province of Ham Kyung, and also by relays of coolies.

In Hooch'ang, a town near the Yaloo, at the furthest point north, we found the presence of a disease much like cholera, that had carried off many of the younger people the month before. No doubt this is partly due to poor living, from which these northern natives certainly suffer.

On leaving Hooch'ang (not marked on any map) we came almost directly south to Changchin on our way to Hamheung, the capital of Ham Kyung province. Transportation here utterly failed us, and we had to remain for a day or two in a wretched filthy inn, waiting hopelessly. Seeing a fishing-rod hanging in an outer room, I took it down and went to the river near by to try my hand, but the owner came clamouring after me at such a rate about his fishing-rod that I was obliged to return it and restore quietness to the neighbourhood.

Just then, fortunately, a rough-headed fellow came by leading a raw-boned old cow, and, learning of our difficulty, he offered to take all our baggage on the one animal to Hamheung (500 *li*) for 22 *yang* (3 dols. 75 cents). Morning came, and this patient-looking animal was piled up till you could scarcely see her; but she got under way and steadily plodded on nearly 30 miles a day to the surprise of all the party but the wild-looking native, who evidently well understood his cow's capabilities. Only on the last day, when there were no beans to be found, did her knees tremble; and we were all much moved by her toil-worn expression. But in the evening, when I looked in at the stable to see how she was, I found her peacefully dining off cornstalks and beans, apparently none the worse for her effort. It was a feat that I shall keep in remembrance to the everlasting credit of the Corean cow.

From Hooch'ang, which we left 27th April, we came 600 *li* over high tablelands that slope north. There was snow at intervals, and as yet very little preparation for spring work. The timber had all disappeared, and the hills were bare. I have never seen any forest lands, such as would be called so in Canada. There are small clumps here and there, and in the neighbourhood of Hooch'ang we were about a day in the woods altogether; but it melted away again, and left nothing but a sprinkling of second-growth scrubby trees so common everywhere. The hills have been wiped bare to feed the kitchen fires. In different places I have seen several varieties of oak, ash, maple, beech, elm, and the *Sophora Japonica*, a most useful tree.

On 3rd May we stopped in a village some 120 *li* from Hamheung. It was on a plateau some 2,000 feet, I should think, above the sea. There were few signs of spring, the snow still lay thick in shaded places, and the people seemed in great poverty. We could get nothing but a few boiled potatoes with salt to breakfast on. We ate what we could, filled our pockets, and started. There was a walk of an hour or more, and we found ourselves at a pass overlooking a green slope of 30 miles, with the Sea of Japan away to the east. In the descent of the next two hours we passed out of winter through a couple of months of spring into what seemed the opening of summer. The leaves were all out, and the grain growing. From here to Hamheung (100 *li*), and from there to Wönsan (270 *li*), we found very good roads and a beautiful country. I look upon the eastern slope of Corea as by far the most prosperous and well cared for.

This district is also famous for its gold. We passed many of the diggings, where we know they have some success by the amount exported yearly from Wönsan.

Since this journey in 1891 I have crossed the peninsula by different roads nine times, seeing very little that was new. The threshing season is, perhaps, the most interesting of all times in which to travel, were it not for the failure of bridges. Grain is bound into sheaves and carried home on ox-racks or by coolie porters, and there stacked up until the harvest season is over, when the threshing-floor is prepared before the door. Mud mixed to the proper consistency is spread over the softer earth and left to harden, and here the threshing takes place. In the case of paddy, where the straw is of great value, it is threshed out by being beaten over a log; the thresher swinging the sheaf, held by a loose rope, first over one shoulder and then over the other. Other grains are beaten out with a flail.

The threshed grain is fanned, swept, raked, and winnowed—one pouring the grain, and another using a mat as a sort of bellows to create a draught. It is then spread out and dried on mats in the sun. When dry, the hulling process follows; sometimes by a stone drawn by an ox that runs as a perpendicular wheel round and round a post, but oftenest by a water-pestle that is turned off and on as required. It is then ground up by hand mill or pestle, and is ready for use.

Everywhere throughout Corea you see fires on the hills, due in most cases to charcoal-burning. These people, while they furnish a very important article of fuel, by their carelessness destroy much of the little timber left.

Pottery, tiles, &c., are burnt in the rudest and most primitive ways imaginable; so with lime. The pit is filled, and after being burned it is covered with earth, a small opening at the top being left. Down this water is poured until all is slaked.

The natives have the names of the so-called five noted harbours of Corea off by rote, as they have their old musty classics:—

1st. Wönsan—Ham Kyung province.
2nd. Kang Kyung—Ch'oong-ch'ung province.
3rd. Wamha—Kyung-sang province.
4th. Chinto—Chulla province.
5th. Kanghwa—Kyungkein province.

Their ideas of harbours are, of course, very different from ours, though placing Wönsan at the head of the list seems to show some wisdom. Wönsan is a very excellent harbour, and could hold all the fleets of the world, I judge. As to the merits of the others I cannot speak definitely.

Rope-walking is one of the most important features of a Corean celebration. They stretch a line across the court, and here the *kwangtă* (actor) performs to the delight of the people, who never seem to weary of the same rather stale performances acted over and over again.

WORKS ON COREA.

Griffis—Corea, the Hermit Nation.
Oppert—The Forbidden Land.
Ross—Corea: its History, Manners, and Customs.
Lowell—Chisun, the Land of Morning Calm.
Gilmore—Korea from its Capital.
Carles—A Trip in North Korea.
Dallet—Histoire de l'Eglise de Corée (especially the Introduction); sur l'histoire, les institutions, la langue, les mœurs et coutumes coréenese.

Dallet and Griffis are the best, it seems to me. The others give a meagre idea of Corea.

III.—COREAN LAND TENURE AND LAND TAX.

By J. H. HUNT, Esquire, Commissioner of Customs and H.M. Consular Agent, Fusan, Corea.

Fusan, 10th June, 1894.

DEAR MR. FOX,—You rletter of the 1st instant duly reached me. My time is so taken up with numerous duties requiring my personal supervision that I regret to say I have little or no leisure left in which to do justice to the queries set forth in your letter. To reply as fully as I would wish means writing a book. As that is not possible, I jot down here a few items which have come to my knowledge during my stay in Corea; and if of use to you in compiling the Report and Paper on Corea for Brisbane, you are welcome to them.

1. *Land Tenure and the Price of Land.*—All land primarily belongs to the King. Subjects acquire it in two ways: (*a*) by purchasing from previous owners, who may have acquired it originally through inheritance, by building on it, or by cultivating it; and (*b*) by "squatting" on Crown land—*i.e.*, land not occupied by a grave, nor a house, and not under cultivation. No official notice is taken of this "squatting" until the fourth year, or rather until the fourth crop is gathered, when an officer is deputed to measure the extent of ground *under cultivation* and assess the amount of taxes payable yearly. The size, class, and situation of the ground is then entered on the Yamen's land registers, and is given a number merely; the owner's name is not recorded. All newly cultivated land is free from taxes for the first three years—hence taxes are collected on the fourth and subsequent years' crops only. The occupant or owner of land thus acquired (and in these parts this appears to be the only method of acquiring it) gets no document from the Government, and should he or his heir at any time wish to sell the land he merely makes out a deed of sale which he hands (with the original acquirer's deed, in the case of an heir) to the purchaser on payment of the price mutually agreed upon beforehand. This deed is not registered by the local official, nor is it necessary to bring the transaction to the official's notice to make it binding or legal. (Last year the Government issued an order that in future the sale of land must be reported to the local official, who is to register same and issue a deed of transfer or a title deed to the purchaser. This new order has, I learn, already fallen into disuse, and the people have reverted to the old system mentioned above.)

The law does not permit the land on the hillside, above what is termed by Coreans the "loins," to be tilled, but this law is extensively evaded, and, except for growing cotton and vegetables, land inside the Söul city cannot be tilled.

Taxes are paid in kind and in copper *cash*. The former goes to the Central Government (granary), and the latter to the local official for "office expenses."

The fields are divided into six classes for taxing, with so many *pu* (a "load"), according to situation and the computed yielding qualities of the ground. A field of the first class is rated at 10 *pu*, a second class at $8\frac{1}{2}$ *pu*, and so on, deducting $1\frac{1}{2}$ *pu* for each class down to the sixth class, which is rated at $2\frac{1}{2}$ *pu*.

Measurements in Corea are not very precise. Four *pu* of rice land is roughly an area measuring 100 feet square—or as much ground as will require 1 *official tu* (*"bushel"—called by the people *mal*) to sow it. For barley, wheat, rye, &c., 50 feet square equal 4 *pu* or 1 *tu*. For each *pu* of ricefield the owner pays to the Government a

* 10 Kuan-sing = 1 Kuan-tu. 1 Kuan-tu weighs $16\frac{2}{3}$ lb. English. The "*market*" *sing* (*tu*) is nearly three times as large as the *kuan-sing*. The taxes are supposed to be paid in *kuan-sing*, but I learn from the people that the native official collects them according to the *market-sing*, while he remits them to the Government in *kuan-sing*.

yearly tax of 2 *official sing* of rice (*"peck"—called by the people *tœ*), and to the local official 2 copper *cash* † The tax for barley, rye, beans, and some other fields is only half that of a ricefield.

The above are full taxes, levied in years of plenty; where the crops are only partially good, about 10 per cent. of these taxes are remitted, and in bad years they are supposed to be totally remitted. The official land measure is:—

‡1 foot square = 1 *p'a* ("handful"). An area of ground supposed to contain from twenty to forty young rice plants.

10 *p'a* = 1 *sok* ("bundle").

10 *sok* = 1 *pu* ("load").

100 *pu* = 1 *kyel*.

The number of *mon* ($\frac{1}{6}$-acre or 733$\frac{1}{2}$ sq. yds.) to the *kyel* differs according to the class in which the field is rated, thus:—

A field of one *kyel* of the	1st	class	has	38	*mon*.
" "	2nd	"		44$\frac{3}{4}$	"
" "	3rd	"		54$\frac{1}{5}$	"
" "	4th	"		69	"
" "	5th	"		95	"
" "	6th	"		152	"

The average yield of a favourably situated ricefield is about 30 *tu* for every *tu* of seed sown; but some fields produce as much as 60.

Although by law the taxes are the same for all, in practice abuses creep in, a small and poor field often having to pay as much as, and even more than, a larger and richer yielding field. One explanation for this is that, as the fields are seldom (if ever) measured a second time in a generation or so (though by law they ought to be remeasured every twenty years), the owner gradually enlarges his field by encroaching little by little each year on the surrounding uncultivated land, paying only the taxes on the original measurements. Land is not sold by any fixed standard. The price of a field or plot of ground is regulated either by the time occupied in ploughing it (this applies more to P'yungyang and the northern than to the southern provinces), and (or) by its average yield of grain per year.

At Fusan the price of a field yielding two crops a year—*i.e.*, barley or rye in the spring and rice in the autumn—ranges from 2,000 to 7,000 *cash* per *tu*, determined by its more or less favourable situation for retaining the rainfall.

The price of a field in which rice only is planted runs from 2,000 to 5,000 *cash* per *tu*, according to its situation and reputed yield.

2. *Crops and their Rotation.*—In fields that produce two crops during the year—say, rice and barley—the rice (paddy) is sown early in the 4th moon (May), transplanted in the 5th (June), and gathered during the 9th moon (October). The field is then ploughed up and allowed to lie fallow for about ten days, when barley or rye is planted. This ripens, and is gathered during the 4th and 5th moons (May and June), after which the ground is ploughed up and water run in. After remaining in this condition for a few days, the field is again ploughed

* 10 Kuan-sing = 1 Kuan-tu.
† The price of a silver dollar fluctuates between 500 to 750 *cash*.
‡ The "foot" varies according to the "class" of the field.

while flooded with water, and the young rice plants set out in rows. Each "setting" contains from two to four plants, and often six, if the field is rich. Little or no manure is employed on ricefields.

When rice alone is raised, the crop is usually gathered later—say, the 10th moon (October-November)—and the field remains fallow until about the 3rd moon (March-April) of the following year, when it is ploughed up and water run over it in preparation for the transplanting of the rice.

In barley, rye, or wheat fields, the seed is sown in the 10th moon, and the crop gathered in the following 5th moon (May-June). Beans (or vegetables) are then planted, which in turn are gathered during the 9th and 10th moons. This ground is usually well fertilised at the different seasons for sowing.

3. *Guilds or Trades Unions.*—There are no guilds or trades unions in this part of Corea, in the European or Chinese meaning of the term. If members of a calling or trade be unduly taxed, or if pressure be brought to lessen standard charges, they pass the word to one another and resolve to resist the innovation.

4. *Pawnshops and how they are Regulated.*—There are no pawnshops proper in this neighbourhood, and no Government measures regulating such concerns. Anyone possessing money is at liberty to lend on articles, and issue or not, as he pleases, a receipt for the articles left with him, stating the interest to be charged (which is usually mutually agreed on beforehand) until the articles are redeemed.

5. *Flora.*—Some day, if I have time, I will try and send you some names of the numerous native trees, flowers, and shrubs in this neighbourhood; but this is a work which will occupy many days.

The rebels, so far, have given us no trouble. With our kind regards.

Yours truly,
J. H. HUNT.

17th.—220 troops from Japan have arrived at Fusan for encampment here to protect the settlement.—J.H.H.

IV.—COREAN CUSTOM OF TABOO.

By the Rev. GEO. H. JONES, Chemulpo, Corea.

Chemulpo, Corea,
11th June, 1894.

DEAR MR. FOX,—In reply to your question concerning "superstitions," I would say that probably the most conspicuous example is the case of the "Taboo." This is very common in Corea. The people hold to the belief in evil spirits, who are supposed to mass themselves on the 1st and 2nd, 11th and 12th, 21st and 22nd of each moon in the east, and that quarter comes under the taboo. All journeys, for instance, from any point to another point directly east are considered unlucky. On the 3rd and 4th, 13th and 14th, 23rd and 24th, the taboo is transferred from the east to the south; on the 5th and 6th, 15th and 16th, 25th and 26th, it is in the west; on the 7th and 8th, 17th and 18th, 27th and 28th, it is in the north. The 9th and 10th, 19th and 20th, 29th and 30th, no general taboo is in force, and the days are regarded as lucky.

In addition to this general taboo, there is a specific one which prohibits certain acts or kinds of labour on certain days, as "digging the ground," "beginning the erection of a house," or "starting on a journey." But for these you will have to consult a native almanac, which not only gives the specific taboo, but also indicates days which are regarded as lucky for the performance of certain tasks.

Hoping these few items may prove of use.

I am, sincerely yours,

GEO. H. JONES.

V.—NOTES ON COREAN AGRICULTURAL INDUSTRIES AND SOCIAL INSTITUTIONS.

By the Rev. M. N. TROLLOPE, M.A., Episcopal Mission, Mapu, Corea.

English Church Mission, Söul, Corea,
7th June, 1894.

DEAR MR. GARDNER,—I much regret to find, on perusal of your letter of 26th May, how slight is the amount of information which I am able to give you on the various points you raise. An extended course of travel in the interior, and years of intimate intercourse with the people, alone would qualify me to answer, with any approach to precision and fulness, the great proportion of the ten questions which you put to me. In point of fact, barely three and a-quarter years have elapsed since I first set foot in Corea, and during that period my time and attention had been so fully occupied with the internal affairs of our infant mission—coupled with the drudgery necessary to secure even a moderate acquaintance with Corean language and Chinese script—that I have had leisure for but little else. In the autumn of 1891 I was absent from Söul for some five or six weeks, during which I made a long and somewhat hasty journey *via* Keum Kang San to Wönsan, and thence by P'yungyang back to Söul. But with that exception, to which I must add the two occasions on which the Bishop has sent me by sea to Newchwang, I have hardly set foot outside the neighbourhood of Söul and Chemulpo. My circumstances, therefore, during my short sojourn in Corea, have obviously not been such as to enable me to be of much service to you as a source of information on the points you raise.

To take those points seriatim:—

I. Crops.—I have no knowledge of the nature of the crops raised in Corea, save such as can be gained by any resident in Söul and the immediate neighbourhood; and as my antecedents have been all rather of an urban than of a rural character, I feel completely destitute of any capacity for giving information on the subject.

II. Land Tenure.—Similarly, with reference to land tenure, my acquaintance with the subject, such as it is, is limited to the tenure of property within the walls, or at least in the immediate neighbourhood, of the capital.

Property in Söul.—Most of the land upon which the houses in the capital stand seems to consist of freeholds of comparatively small size—conterminous indeed, as a rule, with the limits of the houses by which they are occupied.

Transfer of Property.—Property of this kind, the title to which depends on the possession of a very loosely drawn deed executed by the last vendor, appears to pass very readily, upon purchase, from hand to hand, without any formality beyond the exchange of the property with the deeds for a certain amount of cash down.

Title Deeds.—These deeds, which are, of course, executed in Chinese script, seem to be usually drawn up in accordance with some customary form. They are very brief, merely specifying roughly the size, character, and position of the property, together with the date of the sale and the name in full of the vendor, who also signs the document. The name of the purchaser does not appear customarily to enter into the deed, nor are witnesses to the transaction mentioned, unless it be the "house-slave" of the vendor, the property being described as "the house in which So-and-so is the house-slave," and the vendor styled "the master of the slave." Deeds representing the earlier conveyances by which the property has descended to the present owner usually accompany, to the number of two or three, the new deed effected on the purchase of the property. And in some cases these older deeds are stated to be very numerous, and to go back for a considerable number of years.

Division of Freeholds.—In not a few cases in Söul large house properties have been obviously broken up into a number of smaller tenements, and the land on which the house stands into a corresponding number of (apparently) freeholds.

Arable Land.—Arable property consists of either *non* (*i.e.*, paddy-fields) or *pat* (*i.e.*, other fields). We once bought a *pat* in the neighbourhood of Söul, but the method of tenure and transfer appeared in no way to differ from that in vogue in dealing with house property. The only peculiarity lay, to the best of my recollection, in the different scale of measurement employed for the two classes of property. Property which contains buildings is measured by the *kan* or square of 8 feet—so many *kan* of house, and so many *kan* of garden or vacant ground. The field, on the other hand, was vaguely described as being "so much as an ox could plough in half a day," a standard of measurement which, if inexact, has the merit of being picturesque, and which also, if I mistake not, is one in common use among communities in a primitive stage of civilisation throughout the world.

Absentee Landlords.—The prevalent fashion brings as many as possible of those who can lay claim to gentle birth to live within the capital. An inquiry as to the source of the livelihood of any of the more opulent among these gentry generally produces the reply that he possesses *non* (paddy-fields) in the country. If this be so, the country must consist largely of the property of absentee landlords, but I am unable to say anything of the terms upon which they leave, or otherwise arrange for, the farming and general management of their country estates.

Corporate Property.—The "corporate" possession of property appears to exist, at least in the case of some of the more wealthy Buddhist communities. At a point on the lowlands near the east coast, at the foot of the Keum Kang San Range (about 100 miles to the south of Wönsan), I came across large *non*, with farm buildings attached, which were said to be the property of the Buddhist monasteries situated in the neighbouring mountains, and which were being cultivated for the benefit of the communities, and apparently under the superintendence of some of their members.

Hill Lands.—Hill property is said—I do not know upon what authority—not to be subject to purchase, being the property either of the Crown or of certain families which have secured "burial rights" thereupon, and in any case reserved for purposes of burial.

III. Harbours.—Upon the harbours of Corea I can give no information, having never seen any but those which form the sites of the three treaty ports of Wönsan, Fusan, and Chemulpo.

IV. Rivers.—On the subject of the rivers of Corea, their navigability, and the different kinds of boats which ply on them, I would venture to refer you to the Rev. L. O. Warner, who has made several extended trips, covering the north and south branches of the Han, the Imchin (which falls into the mouth of the Han), the Tai Tong (which flows past P'yungyang), and some others.

Upon two points in connection with the rivers of Corea it is obvious for anyone to remark—

(*a*) *Absence of Weirs and Locks.*—The complete absence of any system of weirs and locks reduces the rivers (above the points where they are affected by the tide) to an alternating series of shallows and deeps, the former frequently developing into rapids, which can only be mounted with great labour, and by boats of very slight draught, and which would be fatal to any boats save those of the heaviest and clumsiest construction.

(*b*) *Constant Shifting of the Channel.*—The tropical rains of summer, combined with the extremely friable nature of the disintegrated granite of which the innumerable hills are composed, must continue to make the navigation of the rivers (at any rate in the neighbourhood of Söul) a matter of great difficulty. A cursory inspection of the (usually dry) watercourses which score the country between the hills that surround Söul and the river will convince anyone of the enormous quantity of disintegrated granite which is brought down in the form of fine sand from the crests of the hills by the heavy rains. The consequence is that even in the lower reaches of the Han, between Söul and Kanghwa, the course of the river is constantly changing, very heavy rainstorms bringing down tons of silt, which fill up old channels and create fresh shoals.

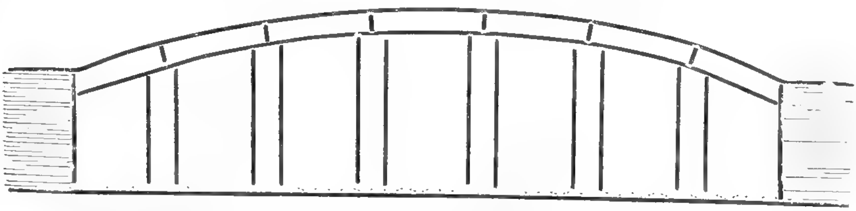
V. Roads.—The execrable condition of the roads is a commonplace with all travellers in Corea, and has, I believe, been freely quoted, in combination with the unsatisfactory state of the currency, as one of the most considerable obstacles in the way of the commercial development of the country. But here, again, I believe that the mischief is largely due to natural circumstances. Corea is an extremely hilly country, and travelling in Corea means an unceasing series of walks up and down long and gradually widening or narrowing valleys, alternating with stiff climbs to the tops of the ridges or passes which separate one valley from the other. Corea is also a country which for a month or six weeks in each year suffers from a tropical rainfall of great persistence and violence. Consequently the indentation in the earth's surface produced by the traffic becomes, at the points where the road climbs the hill ridges and slopes, the natural gutter by which the rain water descends into the valleys, scouring *en route* the surface of the roadway till nothing is left but (in many cases) a mass of loose stones alternating with jagged and protruding rocks; while the valleys, which are almost invariably occupied by paddy-fields, and are purposely kept wet all the year round, tend to become swamps. Frequently, indeed, in parts protected from the violence of the rains, one comes across sections of the road where one might drive a coach and four with ease and comfort for a few hundred yards, but at points where the road ascends a hill it is apt rapidly to degenerate into something resembling the dry bed of a watercourse, while in the bottoms of the valleys, where everything is sacrificed to the cultivation of the rice crops, it not unfrequently becomes a boggy and sloppy track on a narrow causeway, only slightly raised above the swamp of the paddy-fields.

The care of the roads, &c., is supposed to be in the hands of a committee of three (known as the *So-im* or *Sam-so-im*) for each village, or *arrondissement* of a city, with power to levy highway rates, &c. But I am not aware that anything much is done for the repair of the roads beyond the occasional clearing of the gutters and ditches, and the piling of their contents on the roadway. But more serious measures than this are necessary if the roads are to be really made. Dynamite to remove the enormous rocks which protrude from the roadway, and a careful system of grading, together with some adequate measure for dealing with the surface water, are the most crying needs.

Means of Transport.—With regard to means of transport, I have nothing to add to what has been so often and so well said about the extraordinary capacity and strength of the carrying coolies, the magnificent oxen, and the diminutive ponies which divide between them the carrying trade (by road) in Corea. The clumsy two-wheeled carts which one sees in the neighbourhood of Söul are said to travel the whole length of the road between Söul and Enitjyen, on the Chinese border. But I should doubt it. In any case I do not think they are much used away from Söul. I only remember seeing one in the whole 180 miles which separate Söul from P'yungyang, and I have never met one elsewhere except in the neighbourhood of the capital; indeed, in most places I imagine that the roads would be impassable even for them. On the east coast I have seen a sort of rude sledge-cart, without either wheels or slides (such as a sledge would have), used for carrying firewood, &c., on the low level lands between the mountains and the sea. It consisted merely of two shafts, of which the two front ends were joined by a sort of collar resting on the neck of the ox, while the two hinder ends, also joined by a crosspiece, dragged along the ground behind.

Oxen would seem to be the only animals used as beasts of draught.

VI. Bridges—Permanent.—Bridges of squared stone, like those which cross the chief streams in Söul and the neighbourhood, are not unknown in the country, but are probably confined to the high roads leading from Söul to such places as Syon-onen, P'yungyang, &c. Those bridges are formed of huge blocks of squared granite, of which a certain number are set upright in the bed of the stream at regular intervals as piers for the support of the bridge, while those which form the roadway are laid side by side, to the width of 10 or 15 feet, in a horizontal position, with their ends merely resting on the tops of the uprights. These bridges have generally a curved outline, rising to a slightly higher point in the centre, and falling to the level of the bank again at either end.



The sides of the roadway are occasionally protected by an ornamental balustrade, also of granite; but, as apparently nothing whatever is done to secure the foundations of the uprights, the bridges are at the mercy of every "spate," and are consequently generally met with in a state of dilapidation.

The principle of the arch (elsewhere unused in Corean architecture, except for the entrance gates of cities, &c.) is, however, not unknown in bridge construction in Corea. I know of at least one stone bridge—and that apparently an ancient one—of three arches, crossing a small tidal stream on the high road between Söul and Kanghwa, in the district of Keump'o. The arches have a span, perhaps, of 12 or 15 feet, with a mean height, at the crown of the arch, of perhaps a like number of feet from the water's surface.

Bridges—Temporary.—But far the greater number of rivers and streams in Corea are crossed either by ferries (if the river be of any considerable width and depth) or by temporary structures made of the trunks and branches of fir-trees, with a roadway of earth laid upon brushwood. These temporary bridges, which are sometimes of very considerable length, are usually either swept away by the floods in the heavy summer rains or temporarily removed to save them from this fate by the inhabitants of the neighbourhood.

VII. Manufactures.—The paper manufactory outside the N.W. Gate of Söul is well known, and needs no description here. Nor has it been my fortune to discover the people in any other part of the country in which I have travelled engaged in any industry save that of agriculture, if we except such smaller matters as mat-making (of which Kanghwa seems to be a great centre), blacksmith's work, &c.

VIII. Metals.—I have travelled too little in Corea to have had any opportunity of observing the production of the metals or of coal. The metals in most common use (at least in Söul), besides iron and silver, are—(1) a white composition metal called *paik-t'ong*, used for pipe-bowls and pipe mouthpieces, and other articles of daily use and wear; and (2) two other composition metals of a brassy character, known as *not* and *chyon-syek*, used very much in the production of lamps, basins, spoons, and other domestic articles. I do not know of what elements these are compounded. About two days' journey west of Wönsan, near the town of Yangtuk, on the road to P'yungyang, we passed some hot springs of (I believe) a sulphurous charaacter.

IX. Pawnshops.—Of pawnshops I know nothing, except that they form a prominent element in the commercial enterprise of the Japanese in Söul. The name is a purely Chinese one—*Tyen-tang-ka.*

X. Guilds, &c.—My acquaintance with guilds and trade unions in Corea is of a practical, if limited, character. I have invariably experienced the greatest difficulty in getting men of the same trade to underbid one another for a contract, and the existence of the guild system has always been cited in explanation of this. Probably for the same reason it is enormously difficult to get completely rid of the services of a workman (*e.g.*, a carpenter), however ill-satisfied you may have been with his work on previous occasions. You may make your contract with a fresh man when next you have work to do; but the old employee always appears sooner or later, in some capacity or another.

Great Subdivision of Labour in the various Trades.—Perhaps the most astonishing point about the guild system in Corea is the extraordinary extent to which subdivision of labour is carried on in connection with it. I remember one hot summer's day seeing a crowd of well-dressed Coreans gathered in one of the "belvederes" which exist in such numbers in the more picturesque spots in the hills which surround Söul, and I was informed upon inquiry that it was a meeting of the "Worshipful Company of Hat-band Makers"—of gentlemen, that is, whose staple in trade lay in the chin-straps by which a Corean hat is fastened to its wearer's head. The hat itself forms, of course, the staple of at least one other guild —probably of two, one for the brim and another for the crown; and I shall be surprised if I do not discover that yet another guild finds its staple in the "hook and eye" arrangement by which the chin-strap is fastened to the hat. And the system which thus apparently provides a guild for every article, down to the smallest detail, of personal apparel (I believe there is also a guild of dealers in leather soles for shoes) finds expression in all the walks of life. To build a Corean house in Corean fashion one must needs have dealings with at least four separate "heads of departments"—the carpenter, the tiler, the mason, and the paperhanger, each of whom apparently represents a separate guild. Certainly, if an advanced stage of civilisation is marked by the existence of "universal providers," "co-operative stores," and "contractor kings," Corea has much lee-way to make up in her competition with her sister nations of the world.

Books on Corea.—With reference to your postcript, I can only say that I know little about works in European languages treating of Corea, other than the well-known works of Dallet, Griffis, Carles, Lowell, Ross, Oppert, and the more recent work by Captain Cavendish, together with the dictionaries and grammars published by the French Mission, Dr. Underwood, and Mr. James Scott. I have also a manual of the Corean language in French, by a Mons. Camille Trubault Huart (I think a Consul), who, like most other writers on Corean subjects, seems never to have been in Corea. Bishop Corfe has a copy of a book, published early in this century at Batavia, which contains a comparative study of the Chinese, Japanese, and Corean languages, and which is probably the earliest printed book in the Corean language. There are a good many references to Corea in James and Fulford's "Long White Mountain." And I have also seen the Dutchmen's account of their sojourn in the country in the 17th century, in one of the old English collections of travels (I think, Astley and Pinkerton's, but I am not sure). The original work by Hendrick Hamel is, I believe, very rare. There is an attempt at a bibliography of Corea at the beginning of Griffis. And Mons. Collin de Plancy, who was French Consul here in 1891, was engaged in compiling one; but I never heard that he completed his labours.

My letter has grown to greater lengths than I anticipated. And I owe you the more apology for it, as I am afraid that there is very little that is either new or interesting in it.

Very truly yours,

MARK NAPIER TROLLOPE.

VI.—THE COREAN ARMY.

By HARRY H. FOX, Esq., Secretary H.M. Consulate-General, Söul, Corea.

The Corean army is an uncertain quantity: in war time it is said that a force of 100,000 men can be raised, more or less armed and equipped; in time of peace the army consists of some 5,000 drilled soldiers, who garrison the capital and environs, together with about 2,000 or 3,000 men distributed in the provisional capitals.

Besides the soldier or *pounsa* there is the *keso* or bannermen, of whom there are 2,000 or more in the capital serving as police and followers of the high officials. The governors and magistrates in the provinces have similar companies attached to their yamêns.

The above-mentioned 5,000 men—the Corean standing army—have been drilled during the last four years by American instructors, and have attained to a certain degree of smartness in their appearance and movements.

Their uniform consists of a dark-green or black tunic, with white or black baggy trousers, leathern belt, and black felt hat, high-crowned and flat-brimmed, after the manner of the ordinary Corean hat, with a badge in front denoting the regiment they belong to.

Each soldier has two uniforms a year provided for him—one summer, one winter. Most of them are now armed with Remington rifles; but Martini-Henrys, Sniders, Brown Besses, and Portuguese matchlocks are also to be seen. The Remingtons are kept in good order, being inspected once a month by the military instructors.

A private soldier receives one bag of rice, containing about 150 lb., and (nominally) 900 *cash*, about 27 cents, a month. This latter payment is usually in arrear. As a regular supply of rice is all the ordinary Corean lives for, the army offers great inducements to recruits; and they are, on the whole, well contented. There is no limit to service as long as they are able to carry arms. For the purposes of leave the garrison in Söul is divided into three detachments —one-third guarding the palace for three days; one-third staying in barracks and drilling; one-third going home for three days. At the end of the month they are sent down the river in companies to fetch their rice from the junks.

Two regiments, each having three battalions of four companies, are properly organised and drilled every few days by the instructors. A company consists of a captain, lieutenant, and 143 men. The whole regiment is thus about 1,740 strong.

The lieutenants are usually men from the ranks, trained by the instructors. The higher officers are Corean gentlemen and noblemen, and practically useless, as they have no training, the military examinations being confined to archery and deportment.

Drill is held in the mornings in the main street leading to the palace, and outside the north-east gate, where reviews and sham fights are sometimes held. All orders are given in English, and the native non-commissioned officers' pronunciation of words like "halt," "dress," "march" leaves nothing to be desired. The marching in line, fours, &c., and wheeling is very good; and the men seem to take an interest in their work.

The two regiments have thirty Gatling guns, which they are able to work with some degree of proficiency. They have also a battery of Krupp field guns, but want of ammunition renders these latter useless.

Cavalry have never played an important part in Corean warfare, owing, no doubt, to the mountainous nature of the country and the want of proper mounts.

A Corean cavalryman still has a groom to lead his pony, and till quite lately many of them wore armour, and used to occasion much diversion to the crowd at reviews and processions by their frequent tumbles and efforts to keep their seats. A body of 500 men has now been taken in hand by one of the instructors, and is being drilled in foreign fashion. Their uniform is similar to that worn by the infantry, but they have sabres of German manufacture instead of guns.

A few years ago a military academy was founded by the king for the purpose of supplying the army with trained officers. Eighty cadets were selected for instruction, and an American officer was appointed to take charge of the school. Like most other enlightened projects of the king, this was not a success; the numbers gradually dwindled down, favouritism and interest killed competition amongst the cadets, and now but a remnant remain. These are still instructed in topography, military tactics, &c.; and some of them have been put in command of troops.

As regards the fighting qualities of the Corean soldier, the general opinion is (to quote Captain Cavendish—"Corea," p. 43) "that he would be no good in the open, but would fight bravely behind cover, as was shown in the attempted French and American invasions of recent years."

From my own observation I may add that the Corean soldier seems even more peacably disposed than his civilian neighbour. I have never seen them brawling or fighting, although they are very often drunk.

VII.—SEVEN NOTES ON COREA.

By the Rev. L. O. WARNER, M.A., British Episcopal Mission, Kanghwa, Corea.

1. Corean rivers and their navigability.
2. Different kinds of and rotation of crops.
3. Land tenure.
4. Reparation of roads.
5. Bridges.
6. Manufactures.
7. Pawnshops.

(1.) RIVERS AND THEIR NAVIGABILITY.

The Söul or Han River is not navigable for steamers above Pyeng-San. Just above that place there are rapids, which are very shallow, known as the Pyeng-San Yaol; and no craft that will not stand bumping on the stones and being dragged over the shallow parts, scraping along the bottom, can safely travel over them. Then rapids and shallows occur at frequent intervals above this point, though sometimes for miles together the river runs very deep, and in the middle channel would otherwise be quite navigable for river steamers. In the autumn of 1892 I travelled in a small Corean fishing boat up the river Han from Söul as far as the town of Yengchoun, in Ch'oong-Ch'ung-To, which is at least 130 miles from Söul by road, and naturally much further by river, as it is very winding; in the rains the river is navigable a few miles further up still. Large trading junks cannot, however, get so far as Yengchoun even. The progress is very slow up the stream, and trading boats carrying salt, which they exchange for rice and beans, make very few voyages in a summer. A very large quantity of timber is brought down to Söul in large floats, on which the men live while travelling, and cook and sleep. Junks also carry quantities of cut timber for firewood, &c. There is also a tributary river which runs down from the Diamond Mountains, in Kang-Ouen-To, and joins the main stream at Machai, a village about thirty miles above Söul. This river is navigable for junks as far as the town of Nang-Chyen, in Kang-Ouen-To. I went up the river as far as this town in 1892. Nang-Chyen is about eighty miles from Söul by road, but the distance up the river from Machai to Nang-Chyen is at least that, but most likely more. It is very difficult to measure with any accuracy distances by water. All Coreans measure from place to place by land, and tell you those distances usually when asked about the distances by water; besides this, Coreans are very vague in the measurement of even land distances.

At the same time I went across the mountains to the town of An Tong, in the southernmost province of Corea, Kyung-Sang-To. Near that town is the Naktong River, which flows right through the province to Fusan. This is, I believe, a fine river, and is navigable for native craft as far as Naktong, which is a village about forty miles south of An Tong. The distance from Fusan to An Tong is 550 *li*, or about 180 miles; this would make the distance from Fusan to Naktong about 140 miles by road, which would make the river navigable for at least that extent. A steamer runs from Fusan up the river, but I do not know how far it gets up. The banks of the rivers are fairly thickly inhabited, and a good deal of trade is done on the rivers.

In the spring of 1893 I went up the Tai-Tong-Kang or P'yungyang River. This is navigable from the mouth up to within twenty-five miles of P'yungyang city for fairly large steamers, such as the

"Chang Pyeng." Po-san is the name of the port where steamers stop for P'yungyang, and the distance is 70 *li* from this place to the city by road. The river is further navigable for at least 100 miles above P'yungyang to the north for small native craft, peculiarly shaped flat-bottomed boats being used for the higher reaches of the river. There is also a tributary which joins the main river some distance above P'yungyang, and is navigable for about sixty-five miles for native boats.

On the same journey I went down a river whose mouth is close to the north end of Kang Hon Island, known as the Cho-po River. This is navigable for about forty miles for large junks.

The Imchin River, whose mouth is also close to the north end of Kang Hon Island, is navigable for about fifty miles. In the rains this river is said to be navigable as far as the town of Ichyen, in Kang-Ouen-To.

The following are the prefectoral towns to be found close to the banks of the rivers. The distances are road distances—distances reckoning 3 *li* to a mile:—

(1) The Han River (main stream); on left bank, forty miles from Söul, is Yang Keun.
(2) Nye-Ju is fifty-six miles from Söul, on the right bank.
(3) Chung-Ju (three miles from river bank) is seventy-three miles from Söul.
(4) Chyeng-hpoung on right bank of river, in Ch'oong-Ch'ung-To, is 116 miles from Söul.
(5) Tanyang, on the right bank, is 125 miles from Söul.
(6) Yengchoun, on the right bank, is 130 miles from Söul.

On the banks of the northern tributary—

(1) On the left bank is Ka-hpyeng, forty-eight miles from Söul.
(2) On the left bank (three miles inland) is Chun-chon, one of the fortress cities, sixty-eight miles from Söul.
(3) On the left bank is Nang-Chyen, eighty miles from Söul.

On the banks of the Imchin River—

(1) Ichyen, in Kang-Ouen-To, ninety miles from Söul.
(2) Anhyep, in Whangha-To, eighty miles from Söul.
(3) Yen Chyen is fifty miles from Söul.
(4) Machön, in KyungkeinTo, sixty-five miles from Söul.
(5) Imchin is forty-five miles from Söul.
(6) Chang-yun is forty miles from Söul.

(2.) DIFFERENT KINDS AND ROTATION OF CROPS.

Corean farmers, I believe, have no regularly arranged system for the regular rotation of the different crops. The idea that it is best for the land not to have the same kind of crop grown upon it year after year in succession has not, I understand, occurred to them. The land is well manured, and then the farmer plants whatever kind of crop he thinks grows best on the land, independently of any consideration as to what crop he grew last year. Rice is, of course, the staple food of the country, and so is grown most extensively. Rice is sown in the paddy-fields in the fourth month early; it is sown very close, and in the fifth month is transplanted and pricked out in small clumps at proper distances in the duly prepared fields. The rice is usually reaped in the ninth month, and the stubble is left in the ground to rot and form manure for the next year's crop. Of course, owing to the wet nature of the ground required for rice-growing, no other crop is usually grown in a ricefield except rice; sometimes, however, barley is grown in a very dry ricefield.

Oats, barley, wheat, and millet of three or four different kinds are grown fairly extensively in Corea; oats being mainly cultivated in the north.

Potatoes are also grown in the hill districts, very extensively in Kang-Ouen-To, where, in certain parts, they are to the people what rice is in the rest of Corea.

Barley and oats are grown either by sowing in the autumn and reaping in the early summer, when they are called "autumn barley or oats," or else by sowing in the second month and reaping in the late summer; then they are known as "spring barley or oats." The wheat is nearly all "bearded wheat." The flour is very coarse, and will only make into brown bread; but this is probably owing to the primitive manner of grinding, and not necessarily to any inferiority of the wheat.

Beans and oil seeds of various kinds are sown in the third month, and reaped in the eighth. There are also beans of a different kind, which are sown in the third month and eaten in the fifth. Beans are used for food for mankind as well as for horses and cattle; they are usually mixed and boiled with the rice in the country. Beans for horses and cattle are made either into a kind of porridge or else into very hard cake, like the "oil cake" used for sheep and cattle in England—only harder, coarser, and thicker.

Oil seeds are used for making both edible oil and lamp oil.

The best oil produced in Corea is known as "*Cham Kiram*," and is produced from *sesame* seed. This is very wholesome, but has a strong taste which is sometimes considered disagreeable.

The castor-oil plant is also cultivated and made into oil for lamps.

Tobacco is grown largely; it is of a coarse kind; it is sown in the third month early, and reaped about the eighth.

Cotton is sown in the third month, and gathered in the seventh; this is very extensively grown, and is used mainly for padding winter clothes, blankets, socks, &c.

The native-made cloth is coarse and very strong, but, owing to the antiquated machinery, is only made in very narrow widths, so that it must be frequently joined in making a suit of clothes. It is more expensive and much more durable than the cheap foreign cloth imported; but the appearance is not nearly so white and glossy, and it does not "get up" so well after washing, so that Coreans prefer the foreign goods while they remain cheaper than their own.

After the barley or wheat crop has been reaped, it is usual to sow turnips and cabbages for the winter *kimch'i* or pickle.

Cabbages are also sown early in the spring, to form the supply for the *kimch'i* during the summer, &c.

Spinach, a kind of sage, mint, and other herbs are grown; also a kind of water celery, and the roots of various wild herbs are used as vegetables. Persimmons are largely grown, and are mainly used *dried*, and strung on sticks. Kang Hon is supposed to grow the best persimmons.

Peaches, apricots, plums, cherries, nectarines, &c., are grown, as are pears and apples, but they are all very inferior, and are usually picked pretty over-ripe, and so spoilt according to our ideas. Oranges are grown in Quelpart, and a kind of small lime is common in other parts of Corea. The quinces of Corea are exceptionally large and good. Walnuts and chestnuts are very plentiful and good, and in some places fine filberts are procurable. Melons, cucumbers, gourds, and marrows of all kinds grow very plentifully in the summer, and are eaten largely by the people, raw and unripe. With careful cultivation most of the fruit could evidently be immensely improved.

(3.) THE MODE OF LAND TENURE AND THE PRICE OF LAND.

Tenure.—All land in Corea is regarded as Crown property, and is taxed at a yearly rate. The ancient idea with regard to the land was that it all belonged to the king, who was in the position of the father of a large family, and divided it out to his subjects, who were bound to make some return to him for his benevolence, which return took the shape of payment of taxes. Every male Corean is in theory entitled to a portion of the land, not to exceed more than three *mal-chiki*. High and low must share alike, and all men are thus to be on an equality as regards property. At a change of dynasty all the land relapses to the Crown, and should be redivided again amongst every male subject in equal divisions. Thus a common man with a large family of sons would be a far larger land-owner than a high-born man with no children. Property has been amassed by individuals in Corea, because, as the natural consequence of such a division, worthless and idle men soon sold their shares to the industrious. It is curious to note such an advanced "socialistic" idea being thought compatible with a system of despotic government. Of course the probabilities are that such a redivision would never take place, even if there were another change of dynasty. At the present day the land is very largely in the hands of large landed proprietors, who let it out to the peasantry. Rent for land is apparently never paid in money in Corea, but always in kind; the landlord and the tenant share equally the proceeds of the land, while the landlord pays the taxes. All that is produced on the land must, according to custom, be divided into two equal shares between tenant and landlord. There are also country *nyangpans*, who live on their family estates, and have them farmed by the slaves of the family. Also, there are small peasant proprietors who own small estates of their own, and have no dues to pay but the royal taxes. The taxes in the province of Kyungkein-To, which is the royal province, are paid in money; but in the outlying provinces, I believe, it is the rule that all taxes are paid to the king in kind. Of course, rice, the staple production, forms a great proportion of these taxes.

As far as I can find out, no land is entailed in Corea, and all may be parted with by the present owner at will. On the death of the proprietor, all his sons divide the property equally, and though, of course, the elder brother, as elder brother, exercises authority in the division, yet he is not entitled to any larger share merely because he is the eldest son. The daughters have no legal share whatever in the property, though a man is at liberty in his lifetime to give any of his daughters a portion if he wishes. If a man has no issue, his brothers divide the land. It is, of course, the duty of the sons to support the mother if she survives. The sisters of a landed proprietor cannot inherit anything, though he may bestow property on them in his lifetime.

Land is made over to the purchaser in Corea by a title deed, drawn up by the seller, and signed by witnesses; the deed is handed over after the receipt of the money, and is the only means of proving rightful ownership. The title deeds of the last two or three owners are always kept and handed over with the deed of sale to the buyer, forming a guarantee for the genuineness of the sale. Sales of houses and land are private matters, and there is no tax payable to the Government when a sale takes place, though all title deeds direct an appeal to the magistrate in case of any trouble occurring in the matter.

Houses are taxed by the Government according to the amount of ground which they take up. Land is taxed according to measurement.

Small lots of land are usually sold by the *toi-chiki* (10 *toi* = 1 *mal* or English peck)—that is, by the number of *toi* of seed that it takes to sow the plot in question. Larger plots of ground are sold by the *mal-chiki*, or the number of pecks (1 *mal* = about a peck) of seed that is required to sow the ground. Another way of measuring land is according to the number of days or fraction of a day that it takes to plough the land. A man ought to plough in one day about five *mal-chiki* of ground. I believe that although this mode of measuring ground is frequently used in speaking of land, yet in drawing up title deeds the measures of seed required to sow it are the recognised form of measurement.

Good land is taxed more highly than bad, and the amount of the taxation varies yearly. Every house and all land has a fixed "burden" upon it; that is to say, the owner has to pay every year a fixed number of *chim* or *mout*, but the value of each *chim* that the land is burdened with is variable, though this is not the case with the houses. According as the season is good or bad, or possibly according to his own whim occasionally, the civil magistrate fixes the amount that each *chim* is to be valued at. For instance, a property may be taxed at nineteen *chim*: that means that the owner must pay nineteen sums of money in Kyungkein-To, or nineteen measures of produce in outlying provinces; but the value of the *chim*—that is to say, how much a *chim* means—is in the hands of the magistrates. Usually these taxes are very low indeed according to our ideas; but of course great room is left for extortion if the magistrate be so inclined, and this is especially the case when the taxes are paid in rice, as is very largely the case in Iyen-ra-To, Ch'oong-Ch'ung-To, and Kyung-Sang-To, the three southern provinces. Taxes are payable in the twelfth month of each year.

There is no fixed price for land. It fetches, as in England, more if good, and less if bad, and the price given depends upon whether a man is very anxious to sell or not. The usual price varies from about seven dollars to as low as three dollars per *mal-chiki*.

Any Corean is at liberty to reclaim waste land that has no owner, and cultivate it for three years free of all taxes. At the end of the three years he is taxed yearly as the owner of the land.

The usual way of renting a house in Corea is for the tenant to pay over a certain sum of money in a lump to the landlord, who lets it out at interest. When the tenant leaves he gets back the principal.

(4.) REPARATION OF ROADS.

When are the roads repaired (if ever), and by whom? The roads are supposed to be repaired every spring regularly, and at other times if they need it. The civil magistrate is responsible to the Government for their being kept in repair. The villagers along the roadside are held responsible by the magistrate for the repair of that part of the road which is nearest to their village; and the whole road is thus portioned out. The people must find all the stones, &c., required for such repairs, and are paid nothing for their labour. It is part of the duty of each village to keep the piece of road they are responsible for in good order, and if they do not do so they are liable to corporal punishment. The bridges also are repaired in the same way.

(5.) BRIDGES.

Bridges: are there any of stone? Of course none of the *largest rivers* are bridged at all. All rivers are crossed by ferry at certain parts. The ferry-boat is supplied by the magistrate of the district, and the ferryman also appointed by him. Those who live in the neighbourhood contribute to the maintenance of the ferryman. Such is the rule in parts of the country, and only strangers pay a regular toll for crossing; but in Söul, and near large towns, I believe everyone pays every time he crosses; this may, however, be a matter of arrangement with the ferryman. Wooden bridges are very common all over the country. There is a very long wooden bridge across the small river close to Keumchyen, on the road to P'yungyang, and small boats can go underneath it, and do so regularly; but this is the only one so large that I have seen. Stone bridges are of course more uncommon, but I believe they are frequently to be found near large towns. There is a large stone bridge not far outside the east gate of Söul, on the Wönsan road, and another on the Chemulpo road. There are numerous stone bridges over the main ditch of Söul itself. There is a famous stone bridge 10 *li* outside the south gate of Songto, the capital of the former dynasty. This bridge is called the Man Syek Kyo, or "bridge of ten thousand stones," but it is not a very large one really. The old bridge built in the Wang dynasty is still there, but is not used, another one having been built near it for use. The old bridge is disused because on it numbers of the faithful courtiers and adherents of the Wang dynasty were executed, and blood is still supposed to flow there if the bridge is trodden on. There is a small stone bridge turning out of "furniture street" up to Izeng Tong, upon which many Christians were executed in the last persecution. Coreans can build very strong stone bridges, but they do not know enough engineering to bridge a deep or swift river; but any workmen who could build the splendid solid arches to be found in the city gates and other fortifications could also build stone bridges if they knew how to make them secure under the water.

(6.) MANUFACTURES.

What manufacturing industries have you come across? I have seen silk being made in Kang-Ouen-To, at a small village. I believe it is largely made in the country, and can there be bought for about 100 *cash* per *cha*, which is nearly a yard, but of course it is dearer in towns. The silk is coarse, and can only be got in narrow widths. The silk is also dyed various colours, but the dye is not usually fast, and rain makes it "run" very frequently.

Earthenware pottery I have also seen being made, both large *kimch'i* vats and small coarse china vessels. Wooden bowls and vats I have also seen. Iron is also found and worked, as also gold and silver. Paper is largely made, and oil paper, native cloth, wooden shoes, string shoes, leather shoes, hats, *mangours*, &c.

(7.) PAWNSHOPS.

Do you know anything about pawnshops? Pawnshops are very common in Corea. Pawnbrokers are called *Chyen-tan-chapi*. No Government license is necessary out of Söul. I do not know whether it is different in Söul, but I should think not. Anyone may "practise" as a pawnbroker if he likes, and it is a very lucrative calling, but requires a large capital, and so is not overstocked. It is not regarded as at all a "low" sort of business in Corea, and to engage in it entails no loss of caste, though, of course, *nyangpans* are not supposed to undertake any merchant's work. A pawnbroker ranks as an ordinary merchant. Women can engage in the trade without the same loss of caste as those women who sell wine. Of course, as a rule, the pawnbrokers are men, but there are women too. The usual and accepted rate of interest charged is 10 per cent. per month on the money received for the article pledged. Thus, if a man receives 1,000 *cash* for an article he pledges, he must pay 1,100 at the end of the month to get it restored; he *may* arrange to go on paying the interest month after month if he cannot afford to redeem his pledge, but it is also within the rights of the broker to sell it, if he wishes, if it is not redeemed at the end of the time it is pledged for. If a broker sells the pledge before the time is expired, he can be summoned before the magistrate and made to get it back, or pay for it.

It may interest you also to know that suits of clothing may be hired out from shops in Söul for wear during short residence in Söul. There are guaranteed the proper and fashionable Söul "cut," so that no one will know the gentleman who wears them hails from the country. They charge 10 per cent. on their nominal value, however, for every five days' wear, and decline to supply them without good references. Söul men who are poor, and wish to "cut a dash" for a short time, often get their swell clothes like this.

VIII.—FAUNA OF COREA.

Quoted from Cavendish's "Korea and the Sacred White Mountain." London: Philip and Son. 1894.

Tiger—
- *Royal
- *Chinese

Leopard—
- *Maou
- Bulu
- Snow Leopard

Bear—
- *Brown
- Black

Lynx

Deer—
- *Red
- *Muntjae
- *Manchurian
- *Fallow
- Ling yang
- *Huang yang

Argali
Dyigittai (*Asinus onager*) (?)
Ibex (doubtful)
*Pig, Wild
*Hare, Blue
*Fox
Weasel
Marten
*Otter
Beaver
*Badger
*Sable
Ermine

Squirrel—
- Grey
- *Ordinary Yellow
- *Striped
- Flying (doubtful)

*Eagle
*Hawks

Pheasant—
- *Chinese
- *Snow
- *Argus (doubtful)
- Reeve's (doubtful)

*Heron
*Bittern
*Swan, Wild
*Geese, Wild
*Duck, Wild Mallard

Teal—
- *Baikel
- *Ordinary

Ibis—
- *Pink
- **Sinensis*

*Crane
*Stork
*Cormorant
*Pelican
*Quail
*Snipe
*Widgeon
*Hazel-grouse
Capercailzie (in Manchuria)
*Magpie, Blue
*Jay (Brandt's)
*Golden Oriole

Pigeons—
- *Blue Rock
- *Wood

*Kingfisher
Grouse, Black (in Manchuria)
*Shrike
*Woodpecker, Black
*Jackdaw
*Bustard

To the foregoing may be added—

*Mouse
*Bat
*Stoat
*Sparrow
*Lark
*Water Wagtail
*Chatterer
*Cuckoo
*Crow
*Starling
*Turtle

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* Those marked * have been seen in their natural state or as skins

IX.—CONSTITUTION AND GOVERNMENT OF COREA.

By CHRISTOPHER THOMAS GARDNER, C.M.G., &c.

Corea is an independent State under the protection of China, to which country she sends an annual tribute.

The Emperor of China sends an envoy to Corea on occasion of a new sovereign coming to the throne, or a new heir apparent being designated. Their envoy invests the king and heir apparent with the regalia. There is also in Söul, the capital of Corea, a permanent Chinese Residency. The Chinese Resident influences but does not control Corea's foreign relations and internal administration.

Besides the general treaties of protection with China, Corea has entered into treaties with the following countries:—Austro-Hungary. China, September, 1882, regulating maritime and overland trade between Chinese and Corean subjects; March, 1883, regulating frontier trade, Liao-tung and Corea. France, 4th June, 1886. Great Britain, 6th June, 1882; 26th November, 1883. Germany, 26th November, 1883. Italy, 26th June, 1884. Japan, 26th February, 1876; 24th August, 1876; 14th October, 1876; 30th January, 1877; 20th December, 1877; 30th August, 1879; 4th August, 1881; 30th August, 1882; 25th July, 1883; 30th September, 1883; 9th January, 1885; 12th November, 1889. Russia, 25th June, 1884. United States, 22nd May, 1882. The text of the above treaties, except that with Austro-Hungary, will be found in "China Imperial Maritime Customs, iii., Miscellaneous Series No. 19": London, P. S. King and Son, Canada Building, King street, Westminster, 1891.

The constitution of Corea is an absolute hereditary monarchy, but with a power vested in the sovereign to adopt an heir if the natural lineage fails. The present sovereign was adopted, but is a member of the Royal line.

There are three estates in the realm—king, nobles, and common people. Nobility descends to all the children. None but nobles are eligible for the higher civil or military appointments, and even nobles are not eligible unless they have passed an examination and obtained a literary degree.

The Royal family at present consists of the King, aged about forty-two; the Queen, about the same age; the Crown Prince and Princess, and the father of the King.

The officers of the palace are principally eunuchs, the chief of whom exercises considerable influence.

There is a Cabinet Ministry, consisting of three high officials.

Besides this there are two offices and six boards.

The two offices are the Foreign Office and the Home Office. The *personnel* of each of these offices is as follows:—1 president, 2 vice-presidents, 1 councillor, 25 (about) secretaries.

The six Boards are as follow:—Board of Civil Offices, Board of Revenue, Board of Ceremonies, Board of War, Board of Punishments, Board of Works.

Each Board has 1 president, 1 vice-president, 1 councillor, 12 senior secretaries, 13 junior secretaries.

The Home Office was instituted in 1884, and has to a great extent absorbed the functions of the Cabinet and of the six Boards.

The Department of Maritime Customs takes its orders from the Foreign Office, and is organised by a chief commissioner and two commissioners in the Chinese Imperial Maritime Customs, who are lent by the Chinese Government to Corea.

The police of the capital is a military police. The city of Söul being divided into three wards, each ward has its own army division commanded by nobles.

Besides this there are inspectors who itinerate the country and make reports to the King as to the good or bad administration of the provinces.

The metropolis has a governor, two vice-governors, and one deputy governor, the last of whom acts as a judge.

There is a Supreme Court for the country, which sits at Söul. The functions of the Supreme Court are to try State offences and charges against the higher officials. At this court the King sometimes presides in person. Sometimes it is presided over by the Chief Justice, who ranks with and before the President of a Board.

The eight provinces of Corea have 1 governor each, 4 deputy governors of the first grade, 5 deputy governors of the second grade, 74 prefects, 77 district magistrates, 26 assistant magistrates, 122 sub-magistrates. The above officers are independent in their stations, and report direct to the governors of the provinces.

The prefects of the departments in which the treaty ports of Gensan, Chemulpo, and Fusan are situated are given the further title of Superintendents of Customs, and act in conjunction with the Commissioners of Customs lent by China.

There are also a number of town magistrates, who are under the jurisdiction of the various territorial authorities.

There are, further, the tax-collectors—that is, the collectors of land tax, which is paid in the form of rice. This department is ruled by a treasurer and deputy.

The Royal granaries are under three high officials—the superintendent, the director, and the treasurer.

There are five military fortresses which guard the approach to the capital.

In Söul itself there are 4,000 men, who act both as soldiers and police. These men are divided into three battalions. Each battalion has a general, lieutenant-general, colonel, lieutenant-colonel, captain, sergeant. There are besides sixteen brigadier generals.

There is a commander-in-chief of the naval forces, but as yet the only force for him to command are some 200 or 300 men who have been put in uniform, but neither supplied with arms nor drilled. The pay of the soldiers is a certain quantity of rice and about 2s. a month; but the lightness of the work of a soldier, the many privileges he enjoys, and the estimation in which the occupation is held attach many Coreans to the ranks, and make the profession sought after. As a rule, a soldier travelling enjoys free quarters at inns, free run of his teeth at restaurants, an unlimited supply of gratuitous tobacco and drinks, and occasional tips when on police duty. The Coreans have a good ear for music, and the Corean soldier delights in the Western bugle, the calls of which he sounds well.

There is a Postmaster-General, but as yet there is no post office established.

[This was written before the Japanese invasion. The Japanese are forcing changes in the Corean Government.]

[For further information as to the *personnel* of the Corean Government see "China Imperial Maritime Customs, v. Office Series, Customs, Papers No. 32, Shanghai Statistical Department, Inspectorate-General of Customs, 1890."]

NOTE.—In consulting the map the following variations in the spelling of geographical names will be noted :—

Paper.	*Map.*	*Paper.*	*Map.*
Kangwha	Kanghua	P'yungan	Pingan
Yaloo	Yalu	Kyung Sang	Kyeng Sang
Tiu-men	Tumen	Naktong	Maktong
Songto	Songdo	Ch'oong Ch'ung-To	Chung Ching Do
Tchushima	Tsushima	Kyungkein-To	King Ki Do
Whangha	Hwang Hai	Kang-Ouen-To	Kangwen Do
Ham Kyung	Hamkyeng	Kyung-Sang-To	Kyeng Sang Do
Hăchoo	Haiju	Imchin	In-jin

X.—MAPS AND ILLUSTRATIONS OF COREA.

MAPS.

1, Corea; 2, Söul (the capital); 3, Chemulpo; 4, Fusan; 5, Wönsan. The last three places are the three ports in Corea open to foreign trade. Plates LIII. to LVII.

SKETCHES.

1. Gentleman's house, Söul. Plate LVIII.
2. Street in Söul. Plate LIX.
3. Bell tower, Söul. Plate LX.
4. South gate, Söul. Plate LXI.
5. Small street, Söul. Plate LXII.
6. Ground plan, Corean house. Plate LXIII.

7-12. Corean furniture. Plates LXIV., LXV., and LXVI.

13-22. Household utensils. Plates LXVII., LXVIII., and LXIX.

23. Corean porter's crutch (Teegu). Plate LXX.
24. Pack saddle. Plate LXXI.
25. Corean porter in waterproof. Plate LXX.

26, 27. Corean paper manufacture. Plates LXXII. and LXXIII.

28. Corean in deep mourning. Plate LXXIV.
29. Geisas dancing in palace. Plate LXXV.
30. Statesmen in monocycle. Plate LXXVI.
31. Geisa, or dancing girl. Plate LXXVII.
32. Street boys wrestling. Plate LXXVII.
33. Corean woman returning from market. Plate LXXVIII
34. Corean boys flying kites. Plate LXXVIIIA.
35. Corean woman pounding rice. Plate LXXIX.
36. Corean boys playing quoits. Plate LXXX.
37. Corean lady and sedan chair. Plate LXXXI.
38. Corean gentleman and family. Plate LXXXII.
39. Corean gentleman in court dress. Plate LXXXIII.
40. Corean lady in court dress. Plate LXXXIV.
41. Card of Corean gentleman. Plate LXXXV.

DESCRIPTION OF COREAN HOUSE SHOWN IN PLATE LXIII. (K 6).

The walls of the house are marked by thick lines in black ink, doors and windows thus , or thus , according as they are two-leaved or single; sliding partitions thus ....; the upright timbers, resting on granite bases, which form with the roof timbers the essential and fundamental parts of the structure, are marked thus ; the tiled wall enclosing the compound thus ; the places for lighting the fires under the floors are marked thus . [N.B. These also answer the purpose of kitchen-ranges]; the smoke outlets thus ; the portions covered with squares in white signify the existence of a wooden floor laid halfway between the roof and the ground; these chambers, called 다락, are entered from the adjoining 방, or room, and are used as store-cupboards.

Note, that the house would be complete in itself, as a typical Corean dwelling, without the separate *san-chyeng sarang* or summer-house erected on higher ground on the left.

Note, also, that in the ordinary course of events the male members of the household reside and receive their guests in the 사랑, which has its own separate entrance from the road. In the ordinary course of events no one but the women and children enter the inner courtyard and rooms.

There are deep eaves formed by the projection of the roof some 2 or 3 feet beyond the walls on every side of the house. These are not marked in the plan.

The upright timbers, resting on foundation stones marked thus , are almost uniformly placed at a distance of 8 feet from one another; occasionally (as will be seen in the plan) this distance is increased to 12 feet in the larger rooms, and reduced to 4 feet for verandas, and very rarely at more irregular intervals. Houses are always measured by the *kan*—*i.e.*, square of 8 feet.

방	*Pang.*—Room with flues under stone floor for warming purposes.
안 방	*An pang.*—Inner room, of above character, reserved for women.
건천 방	*Kennen pang.*—Ditto, spare room for women.
마루 대쳥	*Maron* or *Tai-chyeng.* — Central hall with wooden floor.
퇴마루	*T'oi maron.*—Veranda with wooden floor (open to air).
부억	*Ponek.*—Fire-lighting space; used also as kitchen.
마당	*Matang.*—Courtyard.
뒤들	*Toni teul.*—Backyard.
산쳥사랑	*San-chyeng sarang.*—Summer residence.
대문간	Great gateway.
즁문간	Second gateway.
헛간	Unenclosed storeroom (for firewood, &c.)
광	Lock-up storeroom.
뒤간	Closet.

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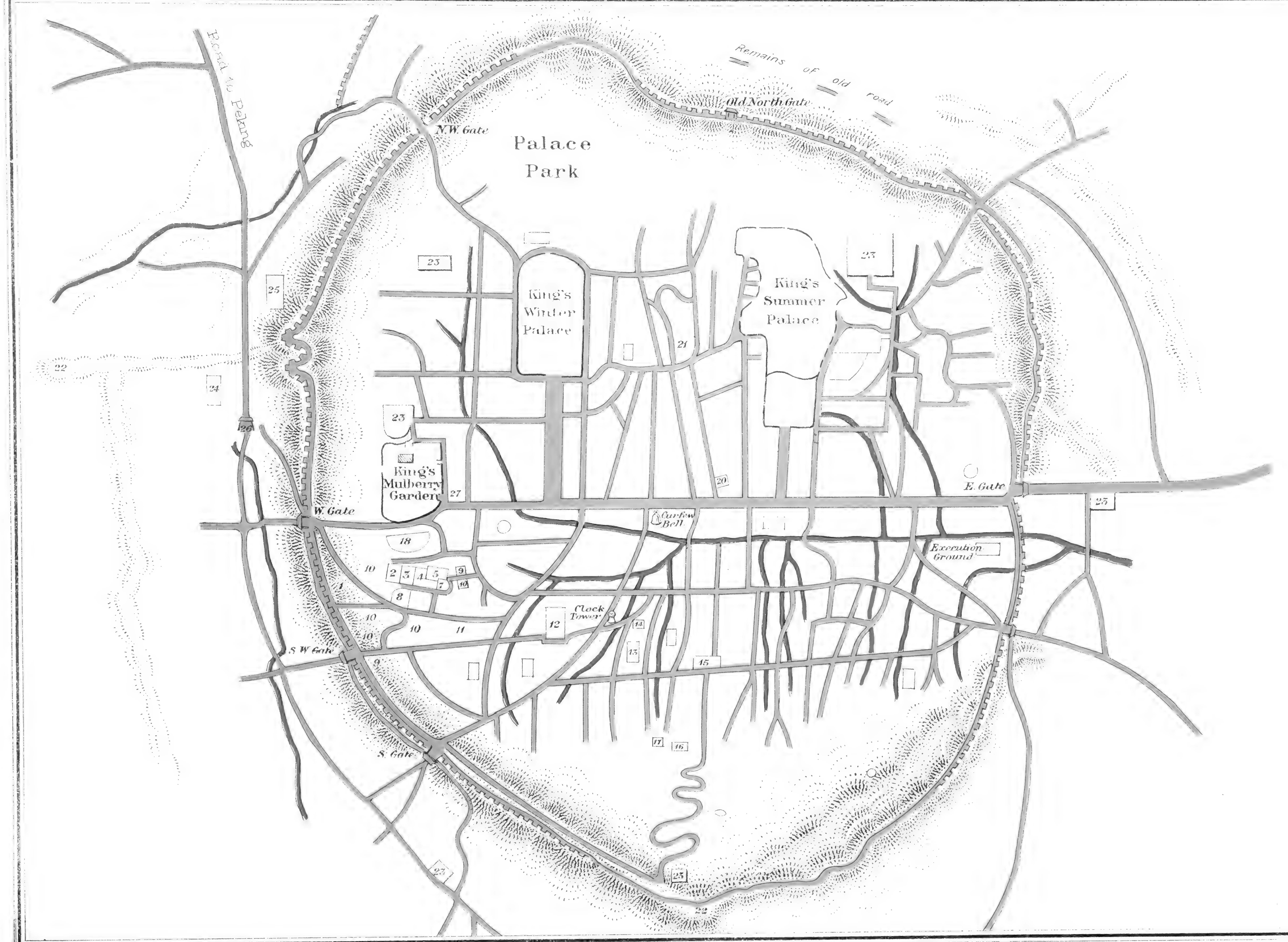


SKETCH MAP OF SÖUL

Scale about 3 inches to the Mile.

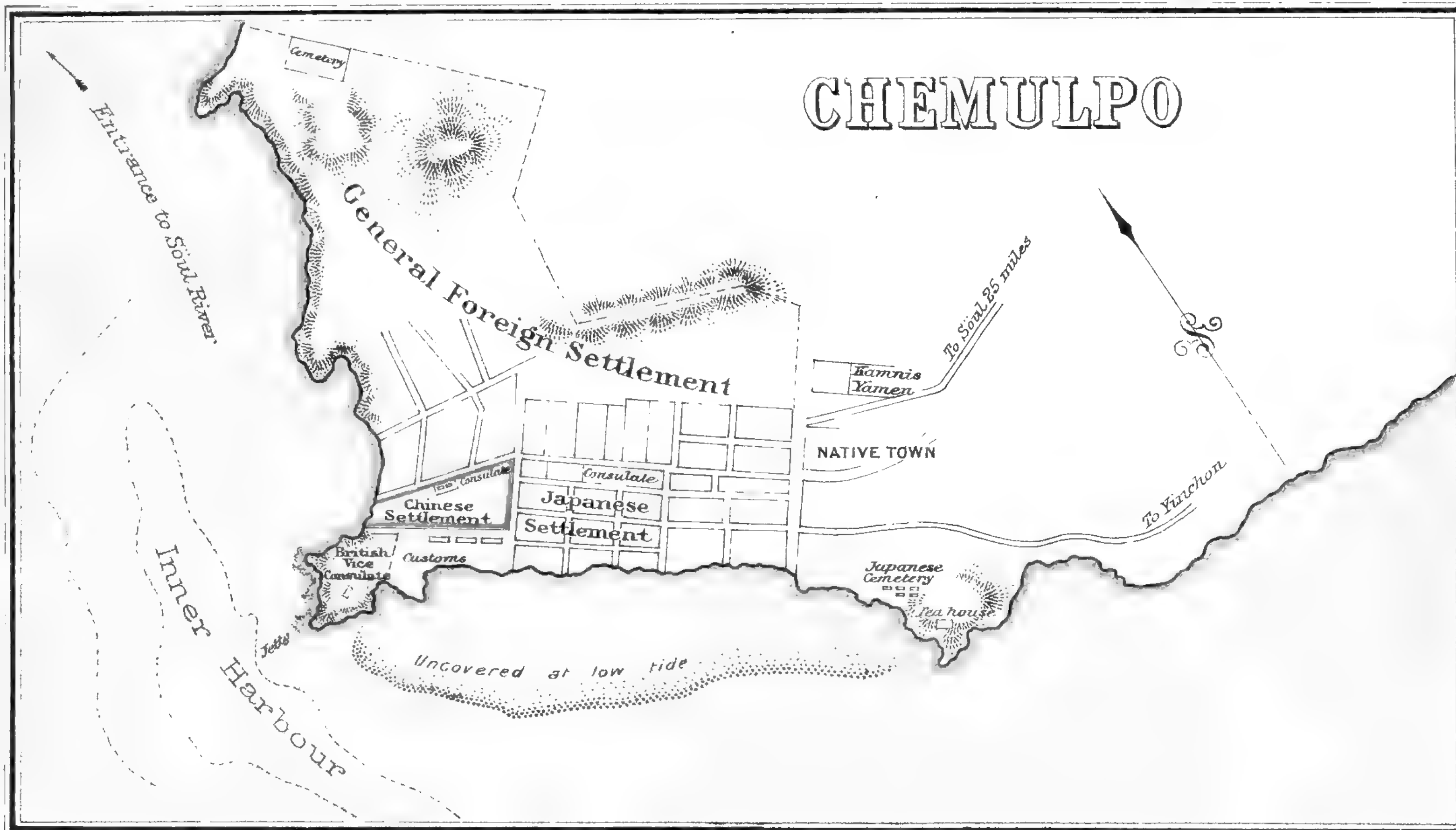
This sketch gives the approximate positions and directions of streets and roads Mr Gardner has walked or ridden over.

REFERENCE

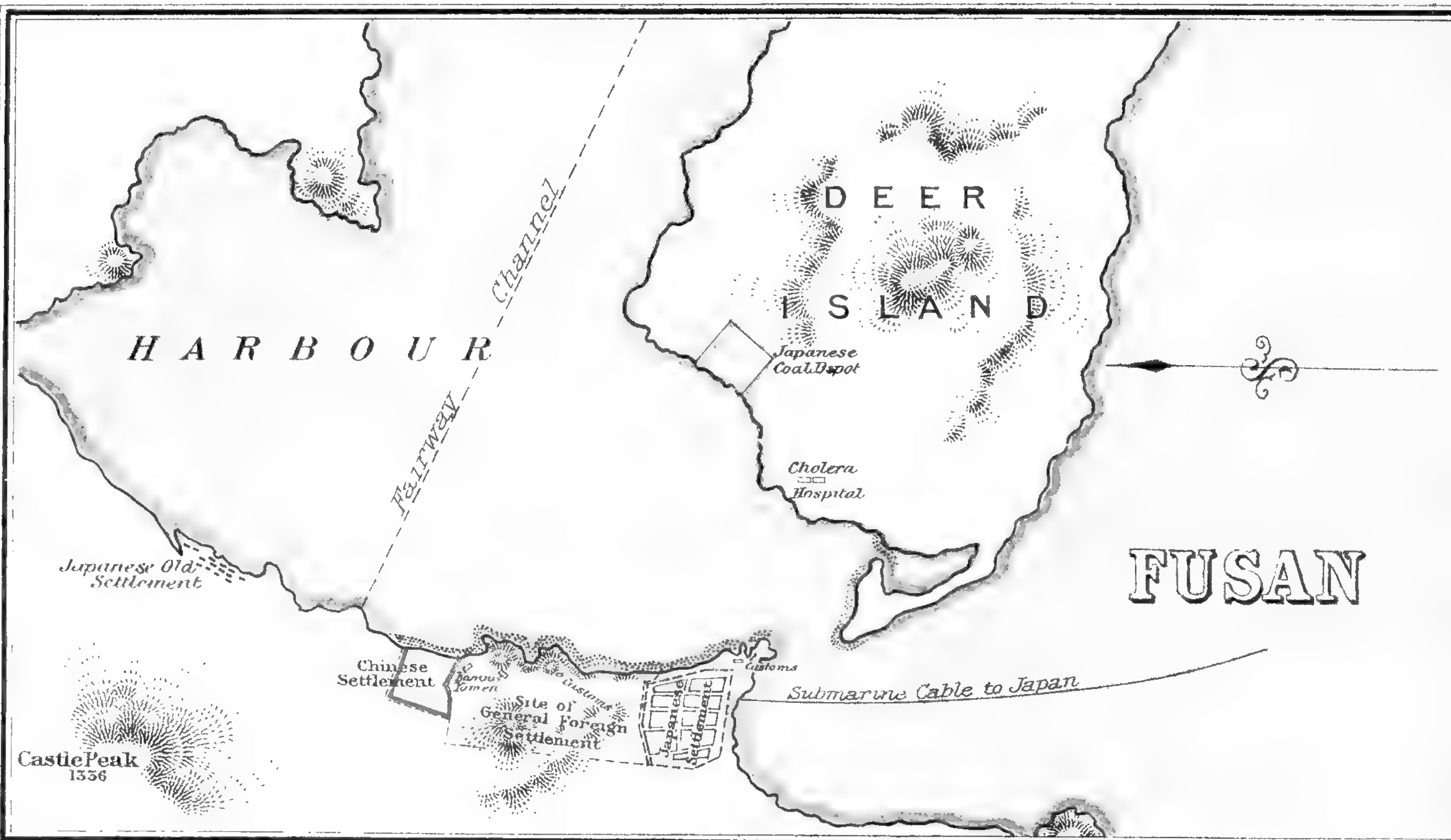
1 French Legation
2 Russian Legation
3 United States Legation
4 Corean Customs
5 British Legation
6 Anglican Sisterhood
7 King's Kitchen
8 Söul Union (Club)
9 French Vice-consulate
10 United States Missionaries
11 German Consulate
12 Former Chinese Embassy
13 Present Chinese Embassy
14 Anglican Mission
15 Roman Catholic Mission
16 Japanese Legation
17 Japanese Consulate
18 Garden belonging to the Queen
19 Residence Col. Nenstead
20 Small Pagoda
21 Foreign Office
22 Beacon
23 Temple
24 Pavilion at which the King awaits the Chinese Envoy
25 Pavilion Chinese rests for the night before entering Söul
26 Archway underneath which the King receives Chinese Envoy
27 Mr Greathouse

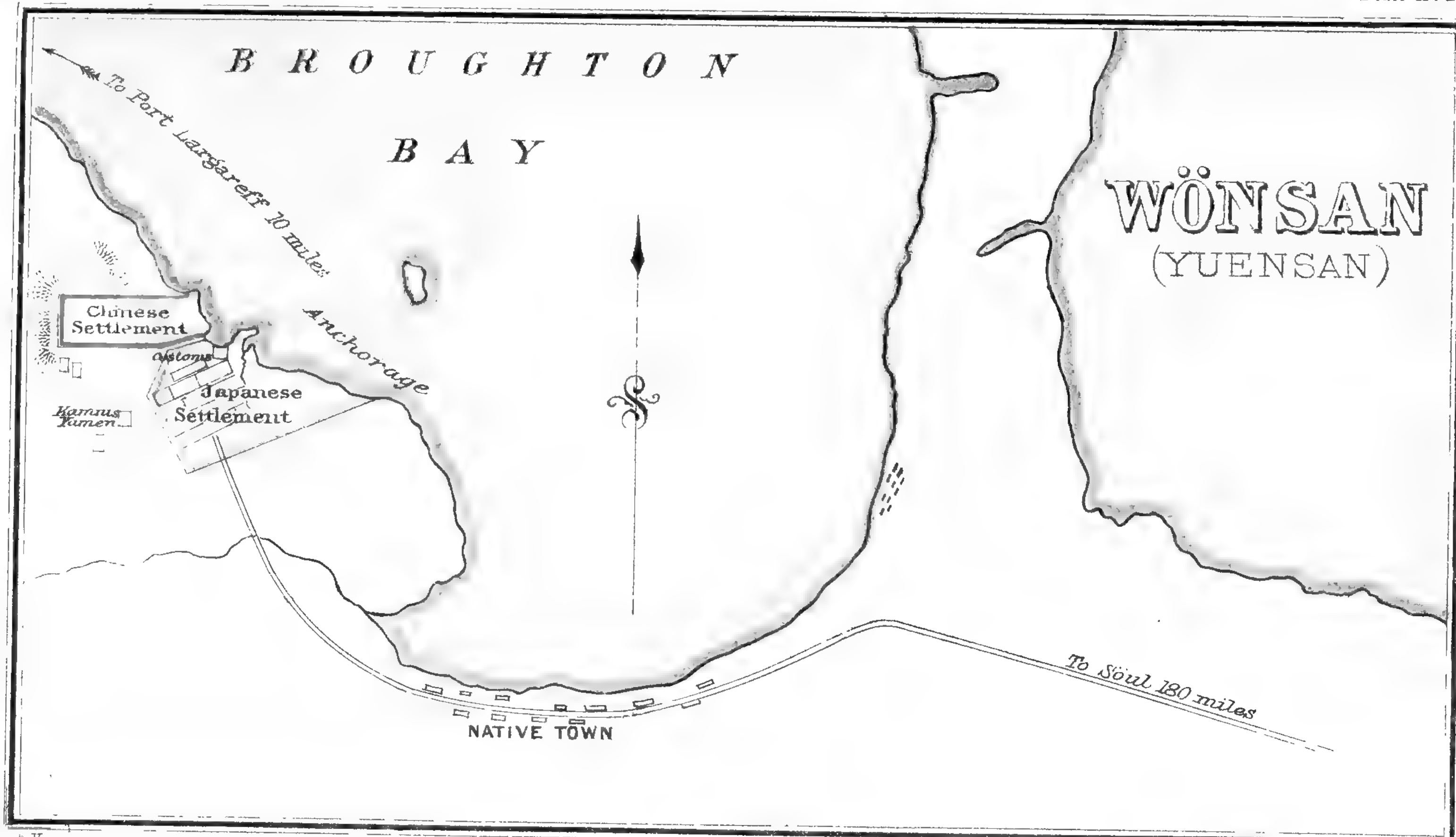
THE THREE TREATY PORTS OF COREA

Plate LV.



K III


FUSAN
HARBOUR
DEER ISLAND
Fairway Channel
Japanese Coal Depot
Cholera Hospital
Japanese Old Settlement
Chinese Settlement
Site of General Foreign Settlement
Japanese Settlement
Customs
Submarine Cable to Japan
Castle Peak
1336



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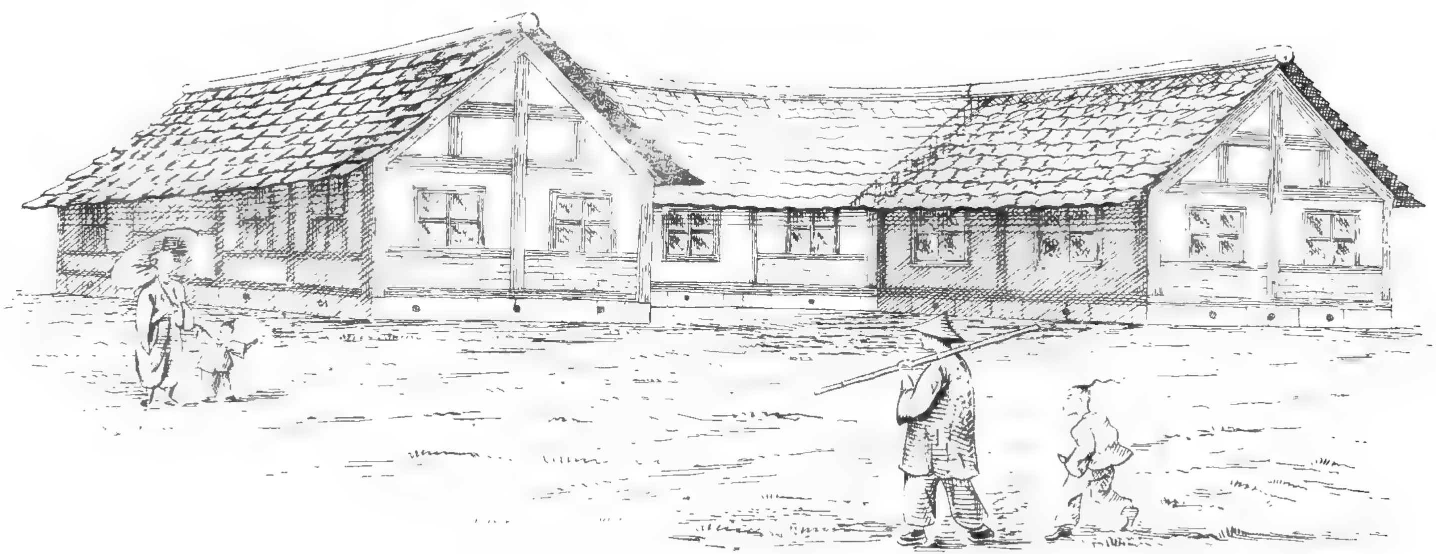
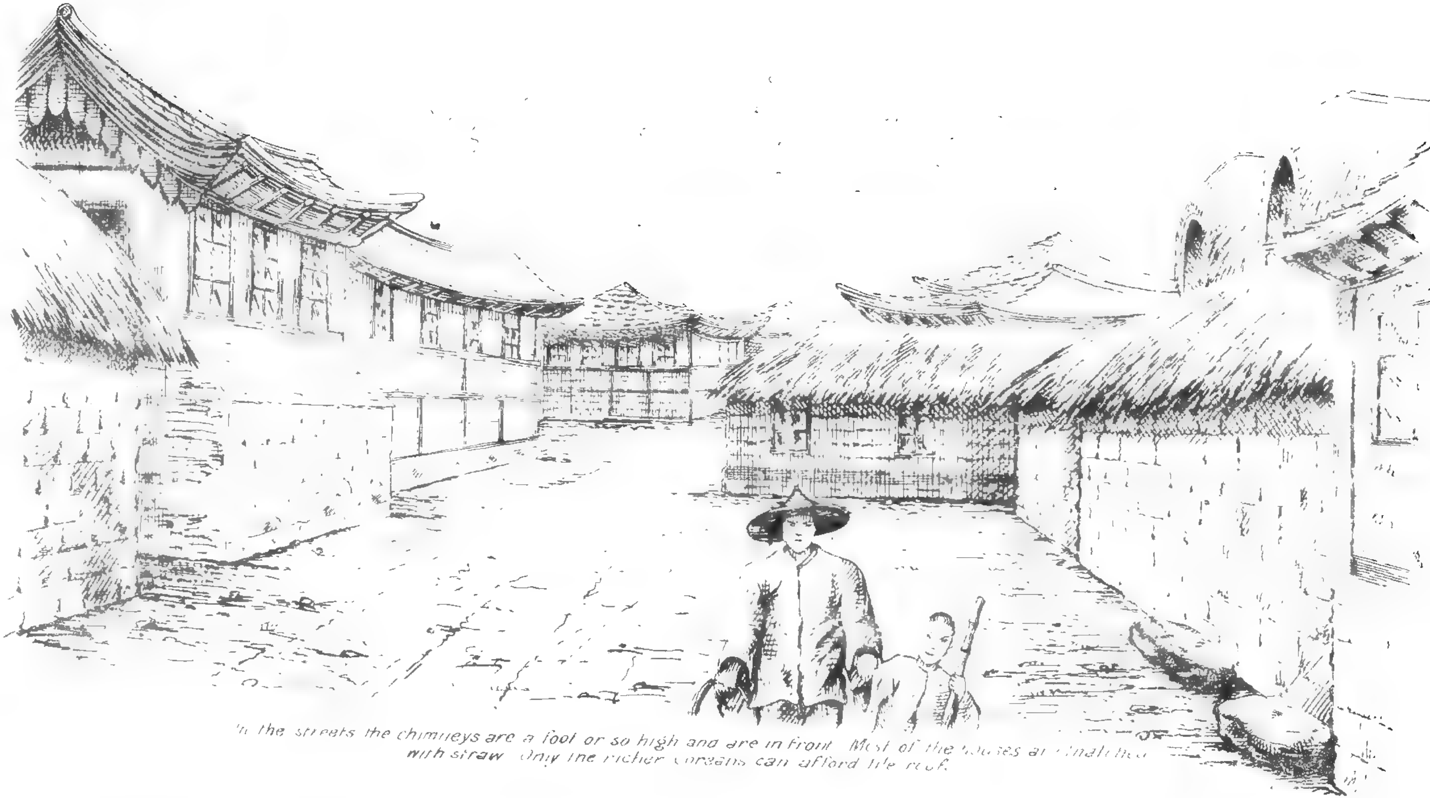
Gentleman's House Söul



Note Few houses in Corea have doors Ingress and egress is done through the windows Almost all houses in Corea are built in squares of 8 feet A Corean room is generally a cube of 8 ft each way. The rooms are warmed by burning brushwood under the floors, the chimneys for letting off the smoke are at the back of the gentleman's house and are 3ft or so high so that the smoke blackens the walls

Street in Söul



In the streets the chimneys are a foot or so high and are in front. Most of the houses are thatched with straw. Only the richer Coreans can afford tile roof.

K2

Plate LX.

Junction of roads leading to the East and South Gates. In these roads hucksters sit and sell their wares under strips of white cotton cloths attached to a frame underneath and placed on a small pole which is stuck in the ground. — The Bell of gigantic size and of Bronze is tolled twice every 24 hours, once at even, after dusk as a signal that the city gates are about to be closed, and once before daylight in the morning when the city gates are open. — The two streets the junction of which is here represented are the principal thoroughfares of Soul. — The two storied building at the extreme right of the sketch is what is called a bazaar, in front of which there is a narrow path for purchasers. — In the upper storey the ware sold is kept. The lower storey is divided into compartments of about 5 feet cube, in each of which a shopman sits and dispenses his wares, which are laid out on a narrow shelf in front. — In the streets are numerous touts to drag the customers to the Bazaar.

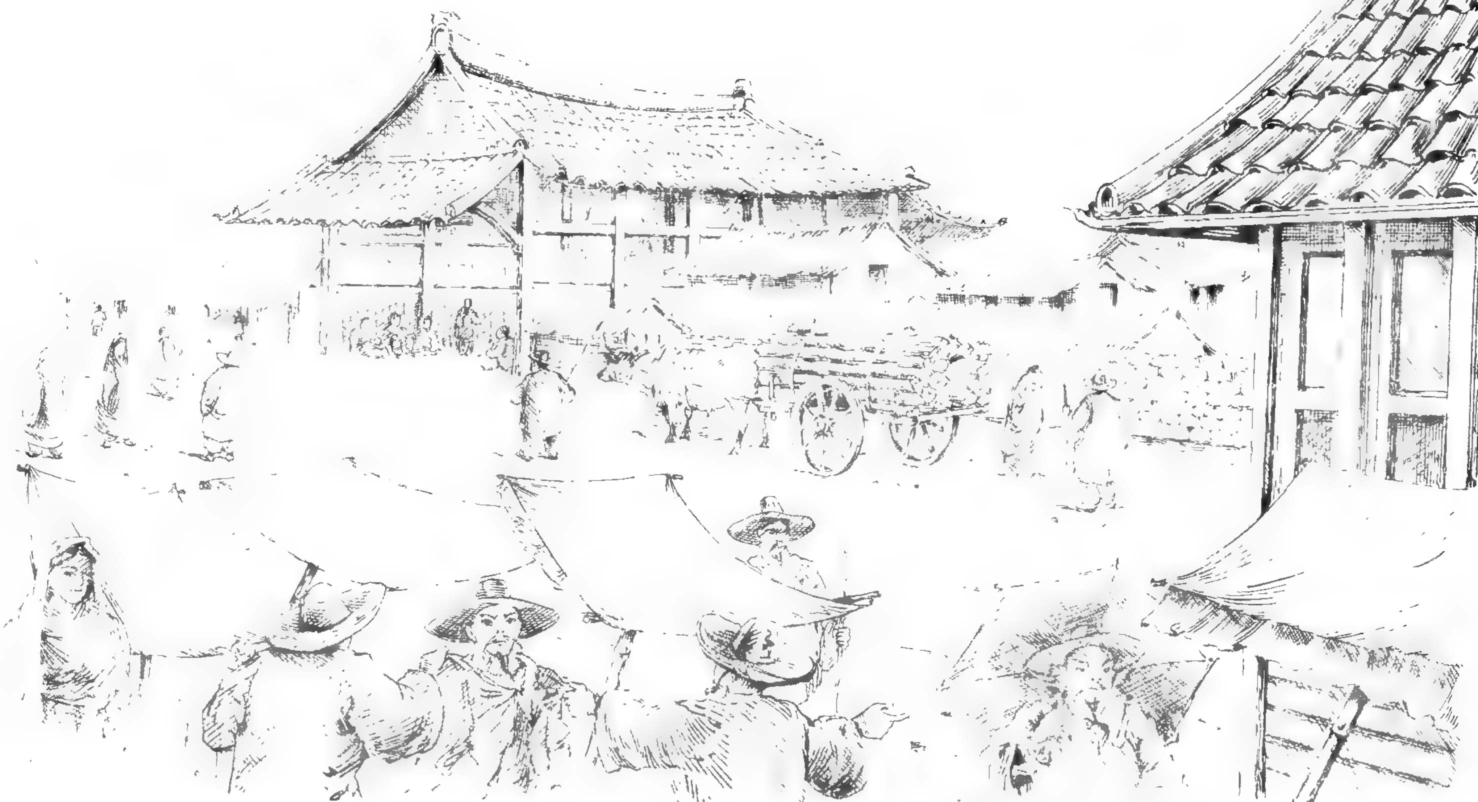
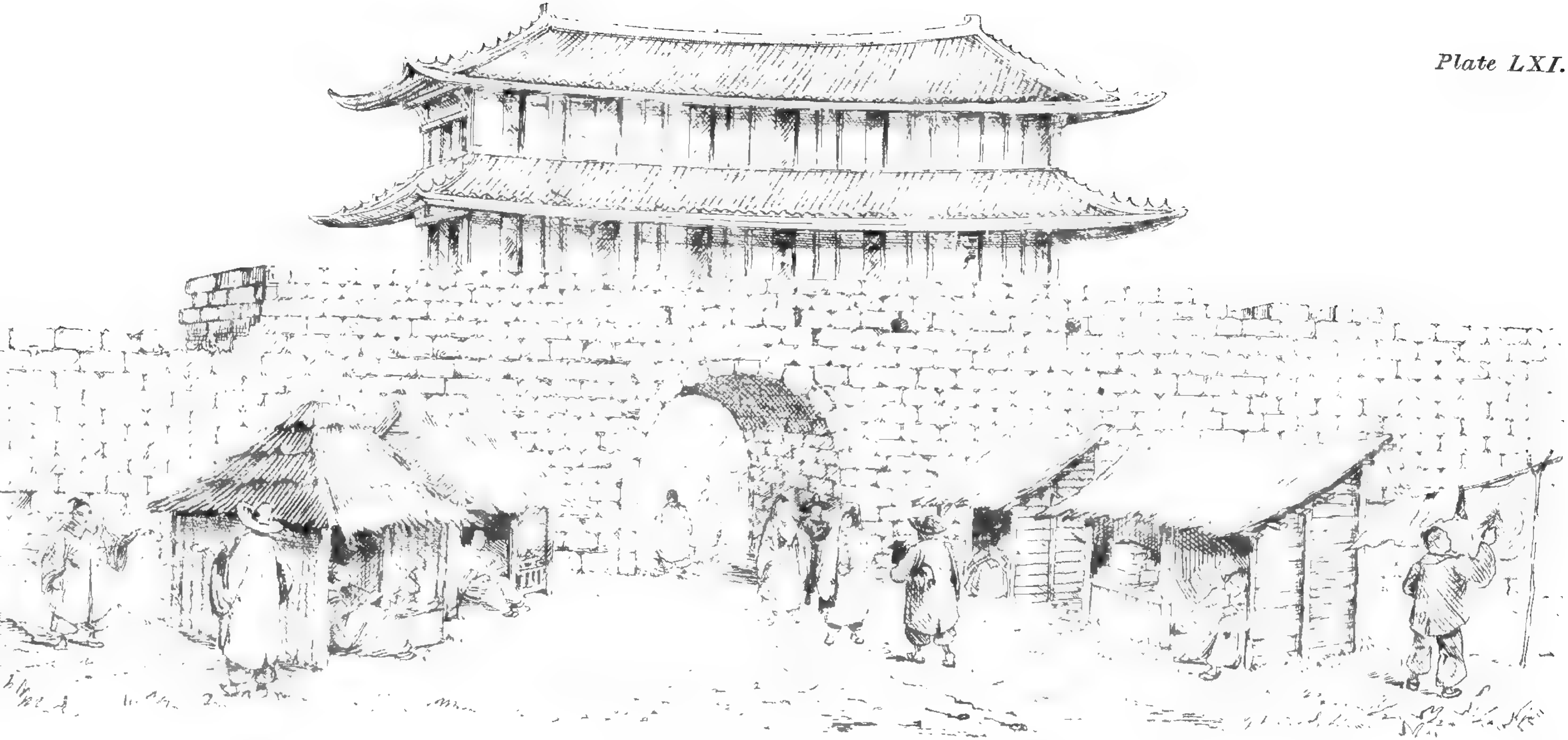
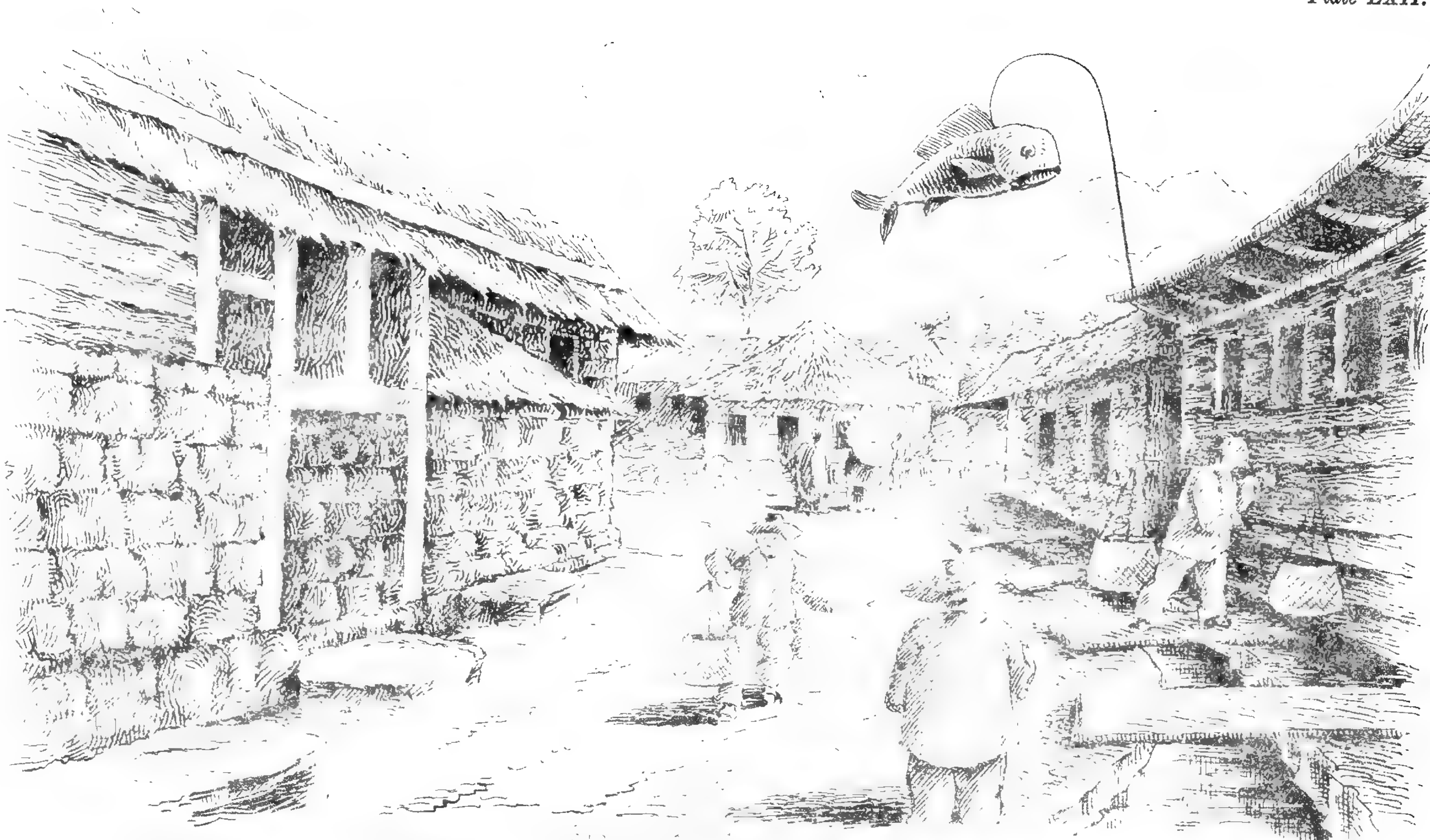


Plate LXI.

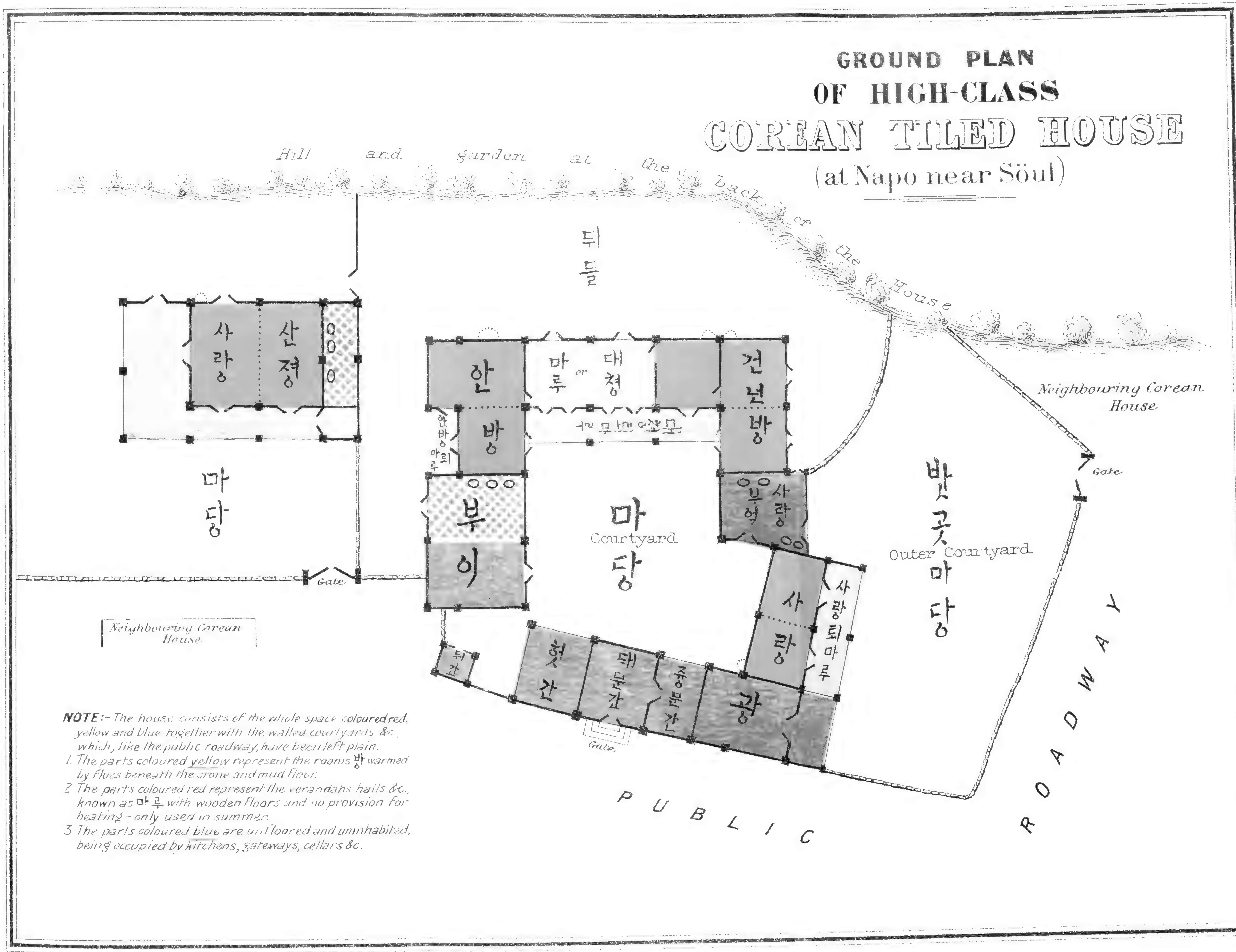


The wall around Soul is mostly [illegible] some 15ft high and some [illegible] wide at summit, only outside the East Gate are there buttresses and bastions. As a defence the wall of Soul is of little or no use

Plate LXII.



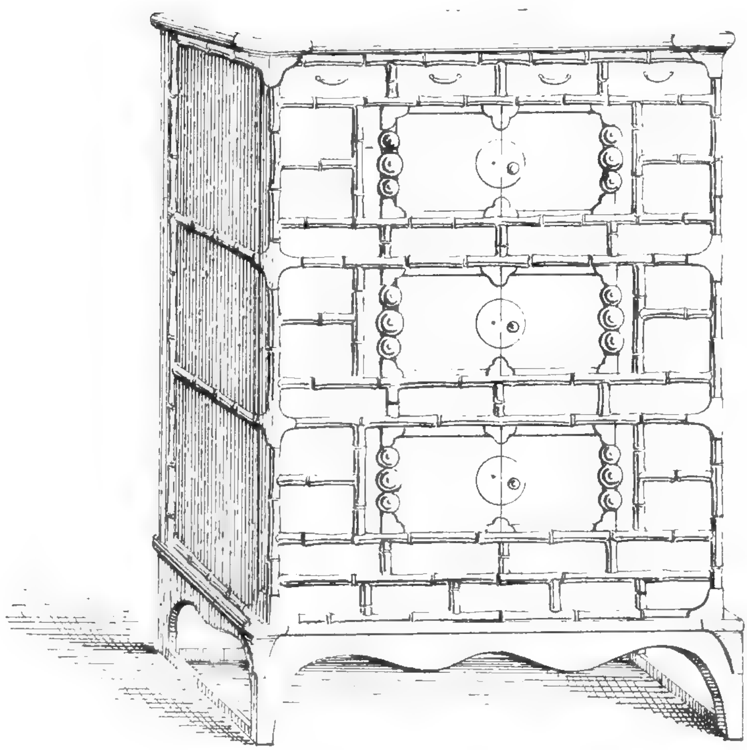
Showing open gutter [illegible] The gutters besides serving as drains are used [illegible] poles [illegible]
of safety when passing [illegible] the pass. Paper fish of enormous size are suspended [illegible] indicate [illegible]
that there is an infant born in the household.


GROUND PLAN
OF HIGH-CLASS
COREAN TILED HOUSE
(at Napo near Söul)
Hill and garden at the back of the House
Neighbouring Corean House
Gate
사랑
산정
마당
안방
마루 or 대청
건넌방
Courtyard
Outer Courtyard
사랑
사랑퇴마루
뒤간
헛간
대문간
중문간
광
Gate
Neighbouring Corean House
PUBLIC ROADWAY
NOTE:- The house consists of the whole space coloured red, yellow and blue together with the walled courtyards &c., which, like the public roadway, have been left plain.
1. The parts coloured yellow represent the rooms 방 warmed by flues beneath the stone and mud floor.
2. The parts coloured red represent the verandahs halls &c., known as 마루 with wooden floors and no provision for heating - only used in summer.
3. The parts coloured blue are unfloored and uninhabited, being occupied by kitchens, gateways, cellars &c.

COREAN FURNITURE

Wardrobe

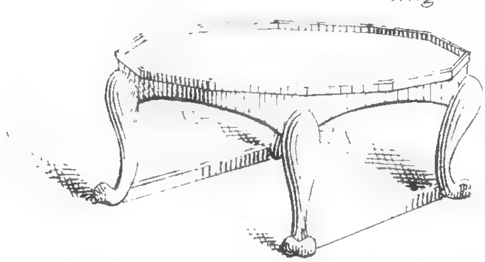
Size 5ft. 6in. by 3ft. 6in. by 1ft. 6in.
Price twenty-four to thirty five shillings



7

Corean Dining Table

Price about one shilling

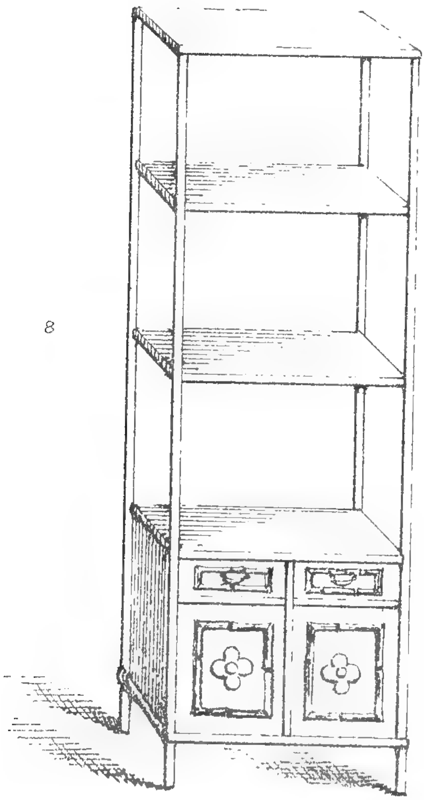


10

This table is an equilateral duo-decagon.
Diameter 16 inches
Height 10 inches

COREAN FURNITURE

8



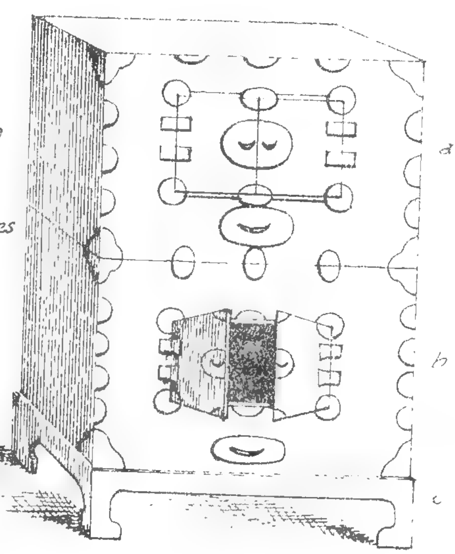
Book-case

Size 5ft. 3in., by 1ft. 7in., by 1ft. 5in.
Price twenty-four to thirty shillings.

Corean Portable Wardrobe

Price six to eight shillings

This wardrobe takes into three pieces
a. Upper part 25in. by 19in. by 12in.
b. Lower part " " "
c. Stand 6 inches high



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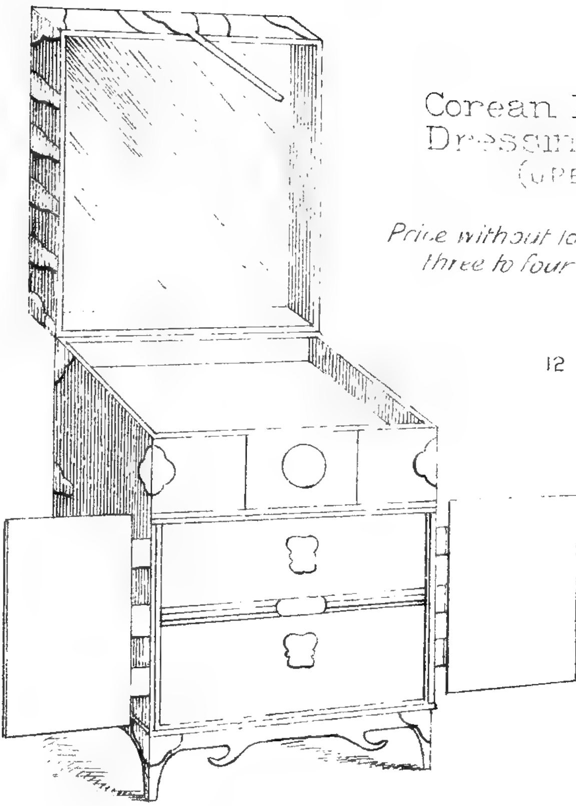
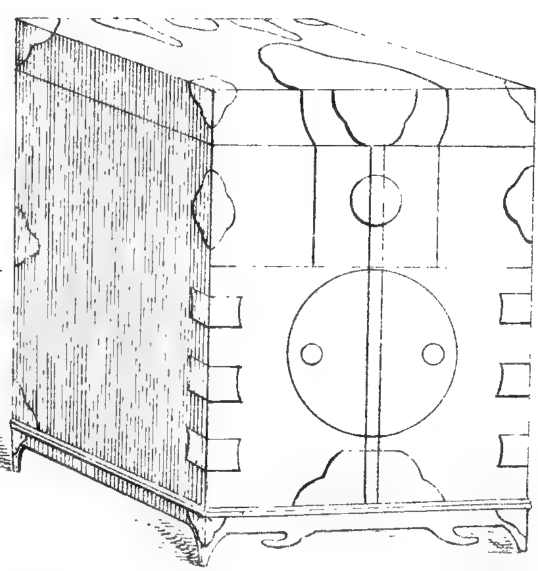


Corean Ladies
Dressing Case
(OPEN

Price without looking glass
three to four shillings

12



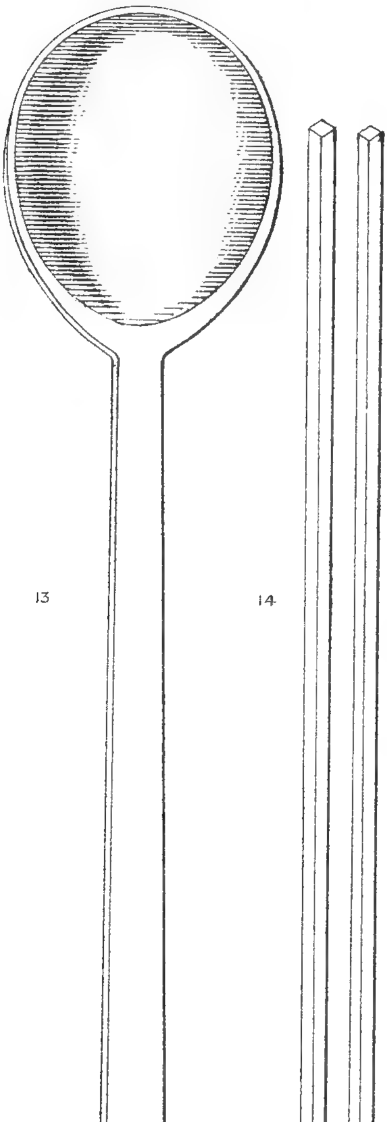
Dressing Case
(CLOSED)

Height 11 inches
Breadth front 9 inches
Length side 13 inches

11

K

COREAN FURNITURE



13

14

Brass Spoon and Chop Sticks

Two thirds the size of article
Important role in a Corean's life "To throw away one's spoon" is a euphemistic expression for dying.

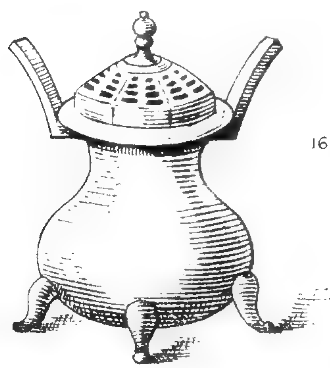
Brass Rice Bowl

Diameter at top 7 inches
" " bottom 2¾ inches
" " height 2¼ inches

15

Brass Censor for burning incense to the devils.

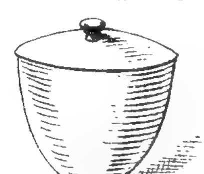
7 inches high
4 inches diameter



16

Brass Covered Wine Cup.

1¾ inch high
Diameter 2 inches



17

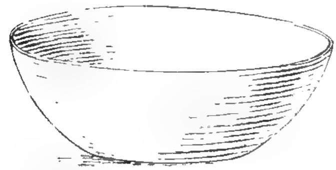
Brass Teacup

7/8 inch high
Diameter 3¼ inches

18

Brass
Corean Sauce Dish.

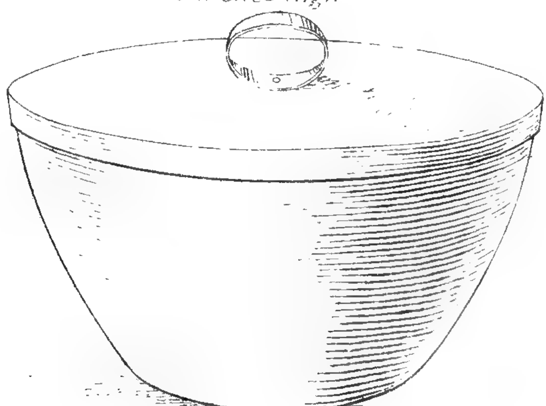
3 inches diameter
7/8 inch high



19

Brass Corean Cougee Bowl. (COVERED)

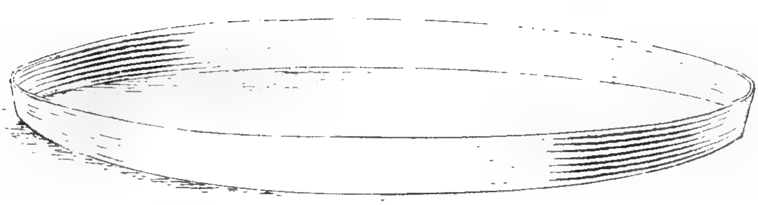
5 inches diameter
5 inches high



20

Brass
Corean Dinner Tray.

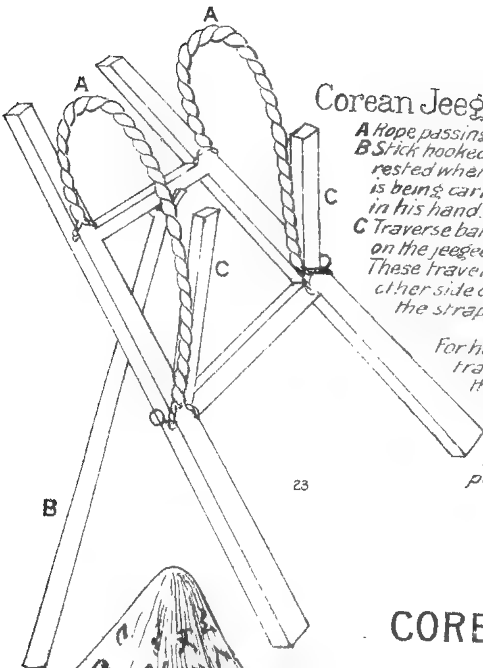
7 inches diameter
1/2 inch high



21

Corean Brass Bell.

Two thirds of natural size. Clapper made of iron.



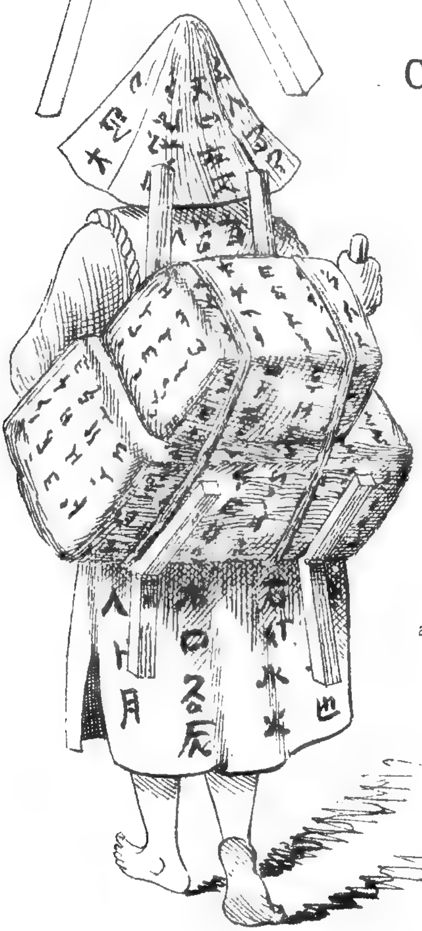
Corean Jeegee or Porter's Crochet.

A Rope passing over shoulder of porter.
B Stick hooked at end on which the jeegee is rested when not carried. When the jeegee is being carried the porter carries the stick in his hand.
C Traverse bars supporting the load placed on the jeegee.
These traverse bars of course are on the other side of the jeegee to that on which the straps are.

For heavy burdens the straps pass traverse wise over the chest of the porter – with high, light, fragile loads, such as crockery an extra strap is attached which passes over the fore-head of the porter and thus prevents the load jolting.

23

COREAN MODES OF TRANSPORT



Corean Porter *in waterproof for wet weather with waterproof covering for loads made of paper (candidates essays at examinations) and afterwards oiled.*

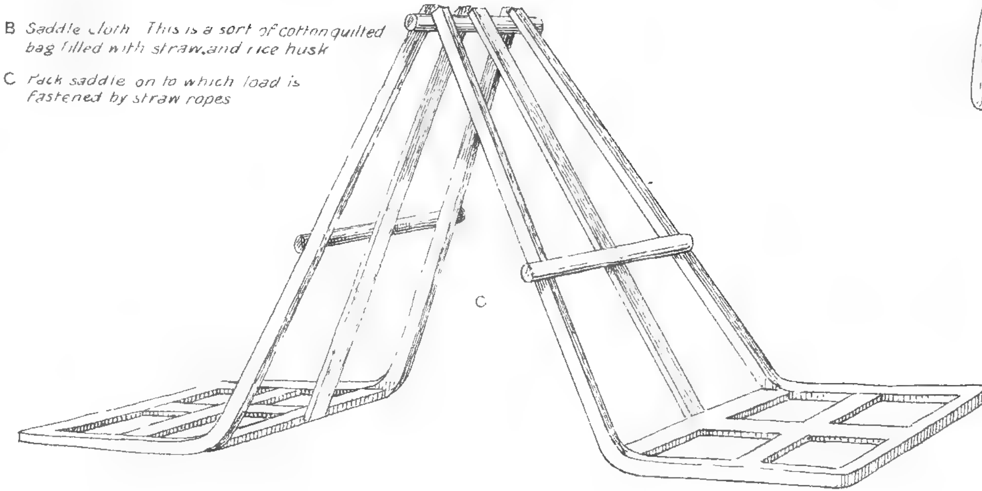
25

Corean Pack Saddle

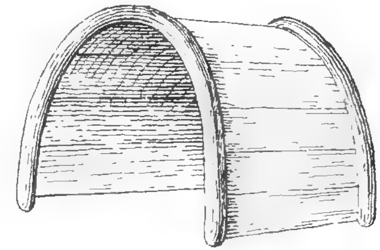
A *Wooden saddle tree*

B *Saddle cloth This is a sort of cotton quilted bag filled with straw, and rice husk*

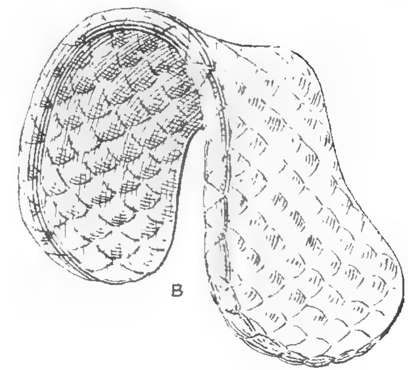
C *Pack saddle on to which load is fastened by straw ropes*



C



A

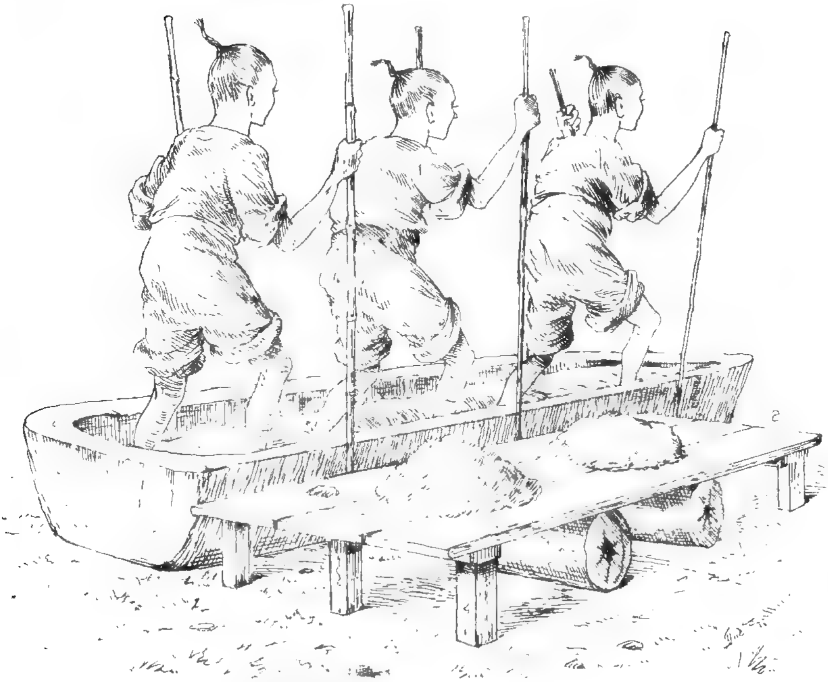


B

For pack cattle a further saddle cloth is used about an inch thick made of plaited straw

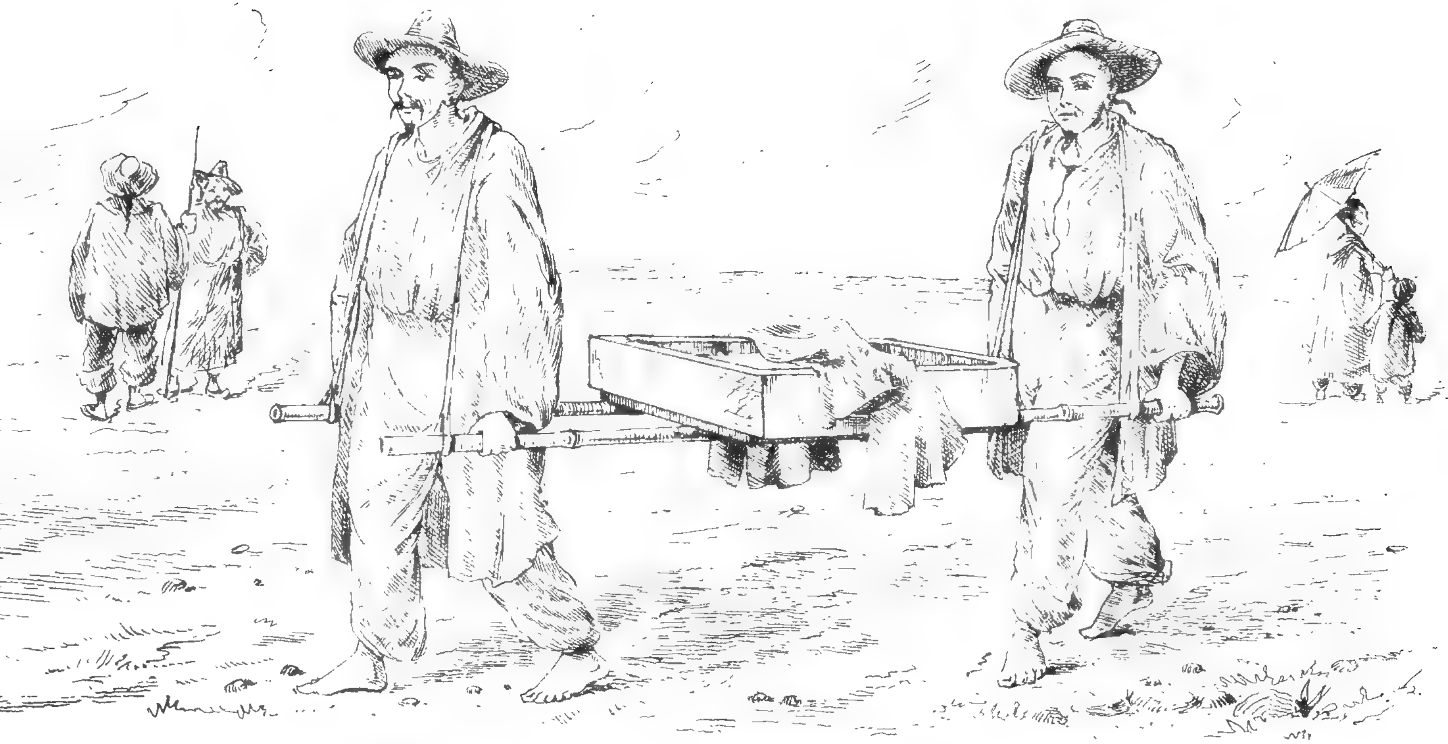
K 24.

Making Paper. Söul, Corea



Trough in which rags and old paper are trodden into pulp.
Table on which pulp is placed when ready for vat

3 Stone vat in which is placed and stirred the pulp. The water has been made glutinous by putting in it twigs and roots of the "Broussonetia Papyrifera"



Carrying the Paper from the Manufactory to Söul

Corean in Deep Mourning

Straw hat & straw shoes, sack cloth clothes & holding a piece of unbleached shirting stretched between two sticks before the mouth

Plate LXXV.

Geisas Dancing the Sword Dance

Plate LXXVI.

Geisa or Dancing Girl

These Girls mostly come from Pingan Province
There are always Geisa girls riding in every procession on ponies Sometimes they are to be seen on foot accompanying a Noble, in a Sedan chair
They do not veil their faces

K 31

Corean Boy's Wrestling.

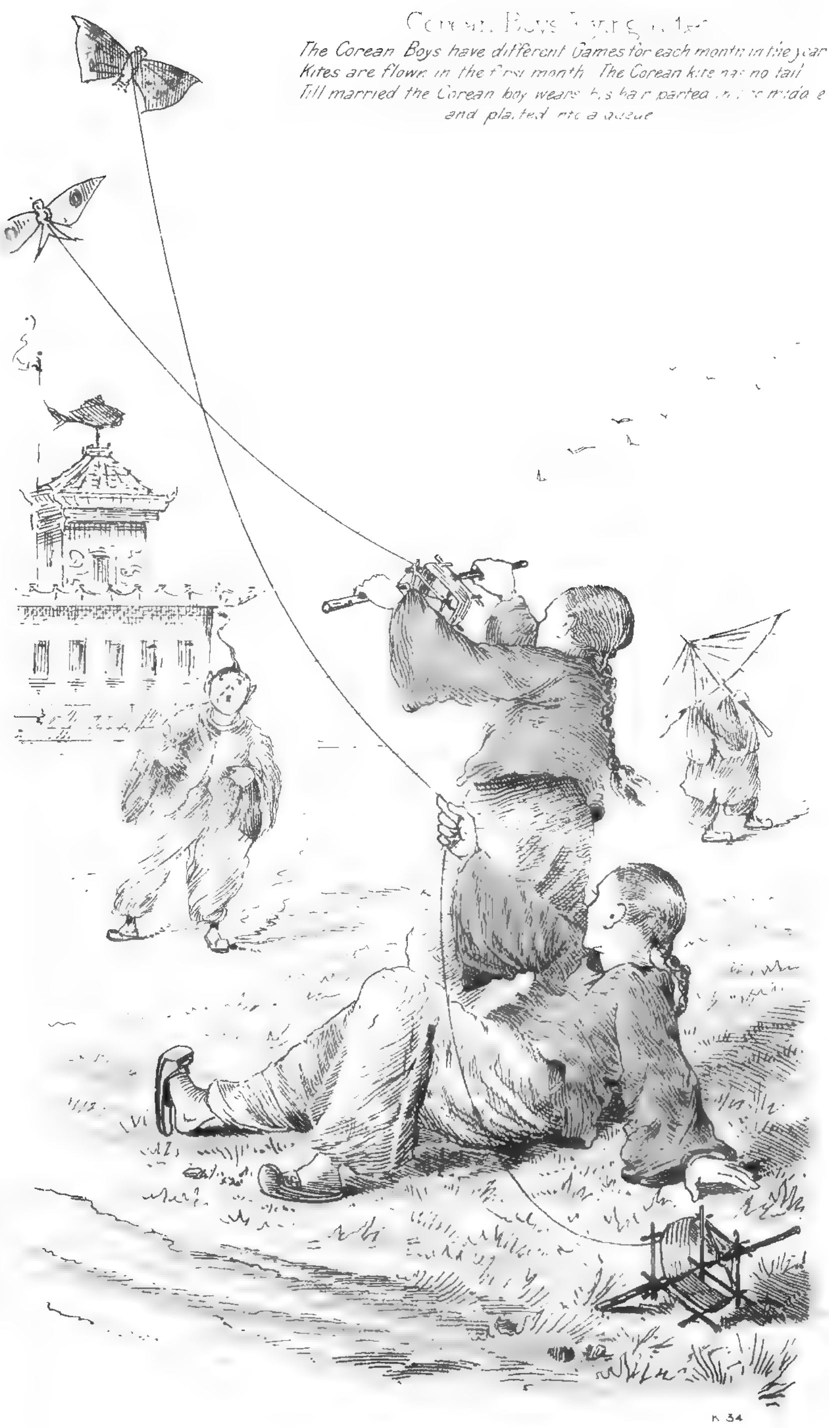
Every boy carries a tobacco pouch made of oil paper,
He generally carries also a coin for luck to which is attached a scarlet or green cord and tassel.

K.32

Corean Woman returning from Market.

The cloak thrown over the head is in Seoul always green with a white lining made of silk. The arms are never put through the sleeves which hang empty. Sometimes when the cloak is worn out the woman wears it with the white lining outside. At the least sign of rain the cloak is taken off and carefully wrapped up lining outwards and poised on the top of the head.

Plate LXXVIIIa



K 34

K 35

Corean Woman Pounding Rice

Corean Boys Playing Quoits

The Quoit is sometimes made of metal more often a bit of round tile.

K 56

Corean Lady and Ladies Sedan Chair

Standing in front of mud and stone wall, stones tied to wall by string

Plate LXXXII.

Corean Gentleman & Infant Son & Daughter

K 38

Corean Gentleman in Court Dress

The belt is very loose and is worn over the chest.

K 39

Corean Lady, in Court Dress

The Corean woman has a great deal of hair, but in the Court dress the hair is much of it false. The hair pins are enormous, they are made of hollow metal

閔泳韶

4.—NOTES ON THE GEOGRAPHY OF THE UPPER MEKONG.

By H. WARRINGTON SMYTH, B.A., L.L.B., F.G.S., F.R.G.S.

General Course.—For those who have not had the opportunity of studying the map of the Mekong as the researches of recent years have drawn it, I may begin by saying that the Mekong or Cambodia River, which debouches into the China Sea in Lower Cochin China (a deltaic tract of its own making), is in Western China identified with the Lantsan, and further north still with the Chiamdo Chu of Tibet.

It rises as the Gergu River in about 33° 17′ N. lat. and 94° 25′ E. long.

From a south-easterly it gradually takes a southerly direction as it passes from Chinese Tibetan territory into the independent country below Chiamdo, through Makham, through Western Yunnan, and ultimately into the Shân and Lao States.

In about 20° N. lat. it makes a great bend eastward to Luang Prabang, whence it resumes its southerly course until the great easterly bend of Chieng Kan and Nongkhai, in Siamese territory, is reached.

From this, the 18th parallel, it resumes, with a wide sweep, its southerly course, passing down the whole length of Siam into Cambodia and Cochin China, and so to the fate of all rivers—in the ocean.

It was long hoped, and by the sanguine French colonists of Saigon affirmed, that this great length of river would enable vessels to work their way from the sea-coast into the heart of the Cambodian Peninsula, that by its aid a great trade route into Indo-China would be opened up, and that thereby, to use the phraseology of the day, it would be possible to "tap" the trade of Yunnan and South-western China.

The prize, if it was to be gained by this road, would naturally go to the French, settled as they were upon its lower course; and the French Government it was which sent away the great expedition made immortal by Francis Garnier's charming book.

Impressions.—When first, after ten weeks' travelling, we struck the Mekong, in the Lao State of Chieng Kong, I remember how we gazed, the whole party, upon its broad surface with the inexpressible pleasure of men who have toiled their way across a trackless wilderness and come suddenly on a broad road: though they cannot see whither it goes or where it comes from, they feel they are linked with their fellow-men again; their eyes travel along it to the horizon, and their thoughts to the far villages and towns to which it must surely somewhere lead.

The satisfaction of feeling you are in visible connection with the sea is very great after a few weeks' struggling in dense forests, where the view is limited for the most part to tree trunks.

The first words of a Siamese at my side were, "Where does it come from?" And standing on the high bank there, watching its enormous brown volume glide past, it was curious to think how much suffering had been voluntarily undertaken by men trying to get an answer to that very question.

I fear the geographical discussion which followed displayed considerable ignorance and much ingenuity; but when, as chairman, I summed up, and told them its whole length was probably over 112,000 *sen*,* and that it took its rise among mountains 2,500 *wah*† in height, whereon the snow never melts, the air resounded with ejaculations such as "Mother! it must be very cold there"; and an elementary discussion ensued regarding the physical properties of ice, and the like, but the fact was evident that I was unanimously accorded a high place among good liars.

Until the famous French expedition under de Lagrée, practically nothing was known of the great river, and very little of the countries it flows through; great hopes were entertained of its possibilities as a highway, and great anticipations were built on these hopes, and it was that expedition which first caused people to suspect they were illusory.

Navigation.—Garnier gave his opinion against the navigability of the Mekong, and in weighing the value of that opinion it must be remembered that he was a sailor, and that when he wrote his opinion he had actually surmounted the rapids and experienced the difficulties which he concluded were too great for "navigation."

And by navigation he did not mean a laborious hauling of small dug-out boats over the rapids, which by their journey the Frenchmen knew was possible, as they saw the Lao people doing it every day of their lives, but a regular and reliable passage of craft of some size and capacity at frequent intervals.

We hear now that with infinite labour and pains the French have got a steam launch up above the Kemmarat rapids in the 16th parallel, whence she has reached Wien Chan at the upper end of a long reach of still waters in the 18th; and that therefore the river is navigable. Navigability might be as well claimed for the jungles of East Africa, because steam craft have been taken through to the great lakes in pieces.

A second fact which gives weight to Garnier's opinion is that he saw the moods of the Mekong in all seasons of the year. No greater contrast can be imagined than that between the Mekong in dry weather and the Mekong after the rains and the snow-meltings, over forty feet above its old level; and the tourist who sees it in one has no conception of the altered aspect of things in the other.

That steamers can ply regularly in the intervals between the bad rapids is obvious, as the average depths below Luang Prabang are from 4 to 8 fathoms at low water; but for any regular navigation tramlines or roads will have to be constructed along the course of the worst series of rapids, if frequent danger and great expenditure of time are to be avoided.

Rapids.—The great series of rapids below Luang Prabang are four in number—the Keng Luang, Chieng Kan, Kemmarat, and Khong; and above that place boats from Chieng Sen must go through the Fah Pa, Keng Haow, Keng La, and Ban Tanoon series.

The length of disturbed waters varies. Those at Chieng Kan extend for the best part of 40 miles in succession, and the Keng Luang series are some 20 miles in length at low-water season.

* 40 sen = 1 mile. † Wah: Siamese fathom = 6′ 8″.

As to whether, then, such schemes will pay becomes a question of some intricacy, and will depend chiefly on the population, which, whatever it may become in the future, is at present infinitesimal.

Upper Mekong.—The phrase "The Upper Mekong" is rather an elastic and uncertain one. If one looks at the whole length of the river, one may with propriety call anything north of 20° N. lat., or of the great Luang Prabang bend, the Upper Mekong.

In Siam and Cambodia one may safely say that the Upper Mekong means the river above Nongkhai or Chieng Kan, until, in fact, it leaves the hill country of the Lao States of Luang Prabang and Nan in 18° N. lat.; the stretch below that point to lat. 14° or about the Khong cataracts being generally characterised as the Middle Mekong, and this, being the more usual, we will follow.

Upper Course.—Of the course and character of the river from its apparent source in Tibet down to Chiamdo, where it is also known as Nam Chu, and is some 10,000 feet above the sea, and on again to the 26th parallel, none of us can give as yet a very accurate account.

It has been crossed by occasional travellers at Chiamdo and in Makham where the two great roads from Ta Chien Lu (18 stages away) and China cross it going westward into Tibet and to Lhasa (46 stages off).

Kinshu.—In 29° N. lat. it will be seen by the map to be confined in a narrow gorge, with on the east the Kinshu, known in Tibet as the Di Chu, within 25 miles of it. This river becomes the Yangtze Kiang, and goes away east through the heart of China.

Meh Ka.—On the west, again, hardly 30 miles away, the Giama Nu Chu drains in the same southerly direction; the latter, in the map lately published by the Royal Geographical Society, is identified with the Meh Kha (a very Siamese-looking name, by the way, like many in the Wa country), an important tributary of the Irrawady.

Salween.—The Salween, which soon becomes the Mekong's western neighbour, is cut off by recent authorities in a rather disappointing manner, for tradition and appearances used to give it a far more northerly source than lat. 27° 80′, the highest point now allowed it.

Mr. Colborne Baber says that of the three rivers, Mekong, Salween, and Shwali, crossed by the Grosvenor Mission on the road from Tali through Yung Chang to Momein, in Burmah, the Salween was in that parallel "beyond question the largest."

The Salween, or Lu Kiang, as it is known up there, is in its way the most interesting, as it is by far the most mysterious, of the great rivers draining out of the south-eastern corner of the great Tibetan plateau.

In a deep gorge among the mountains, with tributary streams few and far between, 2,000 feet below the level of the great neighbouring valleys, with above it peaks rising to 8,000 feet even in its lower courses, it is a scene of wild luxuriant desolation; its course full of rapids, and flanked by wooded heights, and its narrow bed the home of malarial poisons, which at no time of the year seem to get quite dispelled either by sun, wind, or rain of Heaven, or even in the cold months. It is a very curious thing if that large volume of water, drained as we know it is from the narrowest and most confined of watersheds, has its source no further north than 27° 80′.

Such a comparatively short distance from its source we should expect its variations of level to change with frequency and rapidity, with the rain-storms and snow-meltings among the northern mountains, as happens in short rapid rivers. But I am not aware that this is included among the many obnoxious qualities attributed to the river, although between Sukat and Tacaw it has a rise of 95 feet after the rainy season. It seems no better loved by the Yunnanese caravan men on the northern road than it is by the Was and Shâns further south, and they all give its gorges as wide a berth as they can from fear of its malarial fevers. All the people along its course regard it as a stricken zone; and if they must pass it, they do so at the best speed they may, and would no more think of sleeping a night in the valley than of permanently settling there.

Besides fevers of a malarial kind, it seems, like other parts of Yunnan, to be cursed with the plague, and the upper valley is practically uninhabited. I need hardly enumerate all the other horrors connected with it, which lose nothing in the mouths of talkative Shâns who feel themselves well out of its reach, with two or three hill ranges between them and it. Altogether it is probably the most generally unpopular river that ever flowed from hill to sea.

Mekong, below Chiamdo.—To return to the Mekong, Captain Bower is the last man who has crossed it at Chiamdo; and in his chart he shows the road, as it comes southward into Batang, to be surrounded with snowy ranges, all well sprinkled with a community chiefly remarkable for dirt, lying, and thieving, who are independent of either China or Lhasa.

At Gartok the southern road comes in from Dayul, and at the ferry the height above sea-level is probably not much below that at Chiamdo. Between the 24th and 26th parallels there is much very interesting work for future explorers, and we can only conjecture what the Mekong Valley must be—a wild gorge of foaming cataract, with here and there deep, sombre reaches of still water.

Tradition makes the Yang Pi River, which flows into the great Tali lake, a bifurcation of the Mekong at Hsiaotien. If true—which in such a mountainous country seems unlikely—it will hardly surprise anyone who knows the perverse, obstinate, and eccentric character of the "Meinam Kong."

Tali-Bhamo Road.—Thus far down we are in Yunnan, and again in the neighbourhood of a great main east and west road—that from Talifu to Bhamo. Mr. Colborne Baber has given an account of his journey along this route, which to readers of travel has become a classic; and he has shown the extreme difficulties of the route for trade purposes, passing as it does athwart the gorges of the Mekong, Salween, and Shwali, and up over passes, of which one is over 9,000 feet above sea-level.

The heights he gives for the three rivers are 4,700 feet, 2,670 feet, and 4,300 feet respectively, and these are taken as correct in Colquhoun's book. In the case of the Mekong at least one might doubt the accuracy of the figure, seeing that at Chieng Sen Mr. McCarthy, during his triangulation survey, made the river 1,300 feet, and Chieng Roong is generally put down at about 2,000 feet. But, on the other hand, Mr. Baber was a man whose observations could be relied on. His aneroid was carefully tested both before and after the journey, with excellent results. His readings at Tali correspond wonderfully with Garnier's; and on comparison with his other recorded heights along the road there is every internal evidence of its correctness. The result is, then, that from the 25th to the 22nd parallel the Mekong succeeds in falling over 2,500 feet. The road crosses it at a spot where the river is deep and still, five marches from Talifu, where, as Mr. Baber says, it would be capable of boat navigation. It is impressive to think of what comes below that quiet reach.

Shân States.—At Chieng Roong, the head of the twelve States which used to form the Sibsong Para [I am adopting the spelling of McCarthy's map, which represents the Siamese names], we have at last passed out of Yunnan and are among the Shâns, a branch of the Tai race, first cousins of the Siamese.*

Here it is that the Yunnanese caravans come down some 30 marches out of Yunnan, crossing the Mekong on their way from Puerk and Sumao, and striking up among the forests to Chieng Toong, a great central Shân market of some importance politically, and now under England, as having been one of the Burmese Shân States. To it Chieng Kheng, the small State lying to the east of it and on both sides of the Mekong, among others, owed allegiance; and here, doubtless, will lie some of the work of the Anglo-French Boundary Commission, as that allegiance has been for some time uncertain and erratic. The commission is, in fact, to begin work in Muang Sing.

The caravan route from Chieng Roong comes south along the water-parting, where it can clear the deeper streams, which, in the rains in all this country, become impassable torrents, hurling missiles in the shape of tree-trunks or boulders at the unwary traveller who thinks to swim them.

Chieng Mai.—It is fifteen days' march thence to Chieng Mai, the great Siamese-Lao trade centre, where there is quite a little colony of Europeans, consisting of a British vice-consul and outposts of several great trading firms, with a few American missionaries. This place, Lakon, and Raheng are the centres of the Siamese teak trade.

Caravans (Haws).—The Yunnanese caravan men, known by the Siamese and Lao as "Haws," are many of them Mahomedans and remnants of the Taiping rebellion. They were drawn principally from Yunnan, Kwangsi, and the neighbouring provinces of China; and mustering under different colours, from which they have got their names as Black Flags, Yellow Flags, and the like, they settled on Tongking, and have been a terror ever since alike to the French, the Annamites, and the Lao districts round Luang Prabang and Chieng Kwang, which until lately were Siamese.

As traders they are not much less objectionable to camp near than as warriors, if they substitute pitchforks and such simple arms for Remingtons and Sniders; for, what with their habit of never

* Since the above was written Chieng Roong, together with Muang Lem to the westward, have been ceded to China by the recent treaty. China, however, is not to cede any portion of either to any other nation without British consent. Northward the Salween, and to the southward the Mekong, form the frontier. The tendency of the treaty is to free trade between Burma and China, and free navigation is practically granted to Chinese trade on the Irrawady.

changing their clothes, or removing in the hottest weather even one of their innumerable garments, and their dislike of washing, they are no more sweet of savour than of face and manners.

Their packs, as they stand in rows in camp, are guarded by ferocious dogs, who take after their masters in their want of cordiality to strangers. The only things we used to find to like about them were the walnuts, which they bring down from the north, and deal out to the delighted Lao children by way of advertisement.

To make up, perhaps, for their own striking want of attraction, they deck their poor thin mules and decrepit-looking ponies (I won't quote the usual line about them!) in gorgeous trappings, which, after a few months among the bamboo jungles and slippery torrents, get a bedraggled appearance which only adds to the breadth of the grin with which the Lao jungle man greets them.

They usually bring, besides the walnuts, opium, raw silks, bee's-wax, and sheepskin-lined coats, which are admirable things before the sun is up on a January morning, as you stalk through mists at 40° Fahr.

From Chieng Mai they go down to Moulmein to replenish their stock for the return journey, often making this trip two or three times, before starting out homeward, laden with edible birds' nests, mostly from the Mergui Archipelago, cotton goods, pots and pans, and betel-nut, which they sell by degrees on the way.

Betel.—It is by chewing this areca nut with lime that the men and women of the Tai race delight in making objects of themselves; it is said to aid the digestion, and is a stimulant, and in moderation, like opium and tobacco, has great sustaining qualities, especially for men on short commons in the jungle. But used to excess, as it generally is by the idle classes and the people of the capital, it blackens the teeth, reddens and enlarges the gums; and, although credited with keeping the teeth healthy, it loosens them to such an extent that old men and women have to do most of their talking at the back of their throat to prevent their tongues knocking the unfortunate things overboard in an unwary moment; labials are impossible, and half one's difficulties in the language arise from the extraordinary sounds produced.

So fashionable, however, are black teeth, that a distinguished dentist procures sets of false black teeth from America with which to patch up dilapidated dandies in Bangkok; and lately over in Burmah when I asked the lady-killer of the party what he thought of the Burmese damsels, he replied, "Oh, they are not pretty—they have white teeth," and that was the verdict of all the Siamese of the party.

Caravans (Shâns).—Another trade route into Chieng Mai from the north is through Muang Sing, the new capital of Chieng Kheng, and up the fair plain of Chieng Sen; while occasionally a Lao party comes up to that place from Luang Prabang, either in boats or with elephants, bearing gum benjamin, raw silk, and the roe of the famous Pla Bük. The Shân States in British territory send up a fair number of caravans every year to the Chieng Mai neighbourhood. They use, as a rule, docile and plucky little pack oxen, and with their bells and gay colours they are merry people to meet on a lonely jungle trail, especially as they often travel in large numbers with 100 to 200 bullocks.

Their wares are dhâps (or dhâs, as the Burmese call them, the invariable arm of every Lao man), lacquer boxes, in which the buyer will stow his tobacco and betel-chewing gear, tilseed, and chillies, and often some hardy ponies come with them for sale.

These go further down into the Meinam Valley than do as a rule the Haws, returning with salt fish and betel; and their usual road is through Chieng Rai or Muang Fang, both important routes to the north out of Chieng Mai.

The trade with the south from the province of Chieng Mai is almost entirely by boat, along the rivers of the Meinam Valley, the most populated and most possible tract of all Siam.

Products.—The products of Chieng Mai, Lakon, and Nan, the next Lao State eastward, make a pretty list with Padonk and Sapan woods, cutch cedar, rosewood, ebony which is found all over Siam, gum benjamin, sticklac, tobacco, cotton, sugar both palm and cane, tea which grows wild among the hills, and rice of which little more is cultivated than is necessary for the immediate wants of each particular valley. But it does not give a veracious idea of the country to stop there.

Population.—The fact is the whole of this territory is sparsely inhabited, and life in them is a constant struggle against Nature. Most of the towns printed in big type upon the maps are but villages, whose presence you hardly detect when even in their midst. The French maps are the most remarkable in this matter of large type, and you may generally calculate that the population is in inverse ratio to the size of the name of the place. The type may represent what it is hoped it will become, given time and the blessings of civilisation, or what a credulous and ambitious colonial party is desired to believe. But, whatever the cause, a couple of dozen bamboo houses, straggling in and out among banana palms and bamboo clumps by the running water side, and a narrow plain around with scanty room for rice crops, is generally all that represents the Town of So-and-so. Sweetly pretty they are, these little villages, especially after a hard march, when to a weary man they seem heavenly abodes of rest. But 500 yards away you are once more on the hillsides, with the prospect of long days high up on mountain spurs in the blazing sun, or deep down, stumbling in cold, dark torrent beds, ere again you will reach such another grateful spot: at night disturbed by the incoherent cries of men delirious with fever, shouting at the stars; by day contriving how to get them on, and praying for the sight of the grass-thatched roof of some Khache or other hill tribesman. In truth, I always find myself most impressed with the fair prospects of any given part of Siam when furthest away from it; with the reality of endless, trackless, manless forest and mountain-side toned down by the aid of a pipe and an arm-chair.

Boat Traffic.—Though canoes are used above Chieng Lap for short reaches, we must come down below Muang Lim before we find any regular traffic on the Mekong. Here it was that de Lagrée's expedition saw the last of the navigable Mekong; for abreast of Muang Lim they had to leave the river, as they found themselves fairly beaten by the rapids. Time after time Garnier returned to the river at different points as they made their way up to Chieng Roong along the western bank; but the river became clearly impracticable, and at Chieng Roong they struck across to the north-east to Sumao, up to Talifu and into China.

From Chieng Sen downwards we enter upon a very different phase of the river; and to the Lao peoples along its banks, differing as they do, it becomes a high road—and therefore useless as a true frontier. To them it takes the place of elephants, mules, or oxen; it provides them with fish and gold; they build and live along its edge, and people it in tale and story by the aid of their wondrous imaginations until it is to their minds the source of all things—a great Presence and almost a being.

Railways and Yunnan.—At Chieng Sen we are at the entrance to a fine plain which may in the future become better known; for here we are in the track of the railway which Messrs. Holt, Hallett, and Colquhoun have so long and so earnestly advocated, and we are at the one door of South-western Yunnan which can ever be opened to trade. That, at least, is their opinion, as it seems to be that of Mr. Archer, who is the British vice-consul at Chieng Mai.

And when one comes to look at the facts of the Bhamo, Tacaw Ferry, or Tongking routes (and the latter can after all only touch East Yunnan) one is fain to think they have judged rightly, although I take it they have slightly under-estimated their heights in the Mekok Valley, as I think they have over-estimated the populations to be passed through.

The question, of course, rises as to whether the trade of South-western Yunnan is worth the expensive process of tapping by railway. Arguing on the number of caravans which come through (in latter years as many as thirty and as few as six) will give no clue to go upon, nor, in my opinion, does the existing state of trade in Yunnan, or the existing density of population in the Lao States and the Sibsong Para, seriously affect the question. For it must be remembered that war, rebellion, and robbery have devastated all these countries but recently. Their evidences are on every hand, and their results terribly apparent.

At the present day it looks as if the population, which has received a series of checks, is reviving under the present influence of peace and by the aid of the steady migration from peoples on the north and east. According to those who have travelled in them, the countries themselves, whether the rice plain of Talifu, the tea lands of Puerh, or the plains and teak forests of Chieng Sen, are capable of supporting large populations and of enormous improvement. Nature has made these places hard of access, and man has not done them justice.

If man will at last make an opening for them, and by the magic of the iron road tame the spirits which so much interfere with communication between place and place—the jungles are full of them I assure you on the evidence of the most reliable Lao you could meet—then I for one, who am an enemy of railways, because they generally bring in their train billycock hats, brandy, and bad manners, cannot but admit that there is a most hopeful outlook for British trade.

Both Lao and Yunnanese, even malgré the present difficulties of travel, are eminently traders, and enterprising to boot. Many a Lao, for want of elephant or oxen or a handy river, will shoulder his pack with a few rupees' worth of odds and ends, stick half-a-dozen long cheroots in his ear, and start off on foot a month's march over hill and forest, for the pleasure of haggling over his wares at the other end, and the chance of swindling a less acute party out of a few annas. As for the Haw caravan-men, you can see they are born traders at a glance, for they lie with the greatest composure and a richness of invention which is the only sublime thing about them.

The railway, as proposed by Mr. Colquhoun, would come up from Martaban, abreast of Moulmein, to Chieng Mai; and thence follow, to all intents and purposes, the caravan route to Chieng Rai and Chieng Sen.

Thence up the right bank of the Mekong it would cross above the Nam Loey, and striking up the valley of the Nam Bau fetch right into Sumao and the Ibang district. The route is void of any serious engineering difficulties, and follows one of the present main lines of trade of this part of Indo-China; in fact, this is the one road England has open. The race against her has been begun by the French to the eastward with a determined spurt and a long lead.

If Englishmen wait until a sufficient population settles in the countries to be traversed, they may wait for ever; but if they take the bull by the horns and for the moment disregard the question of population, they are much more likely to reap a reward similar to that of the Phu -Lang-thuang—Langson Railway just built by the French in Tongking for strategical purposes, which, passing originally through a thinly populated and uncultivated country, now finds itself the centre of attraction for settlers and traders, and is making enormous sums. However, it is an old truth and does not need insisting on among Englishmen, that communications make trade.

Sibsong Para.—Chieng Lap and the valley of the Nam Ma is the usual way for parties bound up to Muang La and Muang Sai in the Sibsong Para, a district of which until lately very little has been known. Lord Lamington and Mr. Archer have both been through from west to east along different lines. The country partakes very much of the character of the right bank of the Mekong; a confused jumble of hills rising to 5,000 or 6,000 feet, with small, often fertile valleys lying nestling among them at a height of about 2,000 feet. These valleys form the resting-places of the innumerable tribes which are even at the present time migrating south and south-west, to enumerate which would be tedious to those who had to listen. But I may mention the best known of them: the Yao Yin, who approach very distinctly to the Yunnanese type, the Muser, the Meos, and the Lu; the last being so much like the Lao that when fording a river (for which operation their clothes go upon their heads) one may mistake them for Lao, both from their speech and their tattooing, the latter extending from waist to knee.

Lu.—Of all the tribes I met and one is constantly meeting gangs of travellers with a new name and a new dress—the Lus were the jolliest. These hill tribes are invariably described by those who have been among them as the cheerfulest, gentlest, and simplest of honest folk, brimming over with friendliness and hospitality, and of them all the Lus were our favourites.

Their dress first earned them our esteem, for it is nothing more or less than that of the stage pirate, such as one might see in the "Pirates of Penzance"; very wide blue trousers, with a gay trimming at the ankle, brought in tight at the waist, blue double-breasted jackets with little gold or silver buttons, and a white, green, or red turban tied tight round the head, from which their central tuft of hair and the two points of the cloth stand up defiantly, while over one shoulder is slung the trusty dhâp. The women are often almost fair, and are equally tasteful in their rig, with their home-made petticoats of horizontal colours, a short double-breasted coat, more gorgeous than the men's, and often a turban round their knotted hair.

I never met people so determined to make the best of everything, little enough as their everything is, poor souls; and it was a revelation to a Saxon, who loves his growl, to live and journey with these people, watching their invariable good temper, and the laughter with which all hands would greet every misadventure. They seem to have acquired more civilisation than many of the other tribes, and have settled and cultivated in their lovely valleys. Some have come south of the Mekong, and even built monasteries; and though they by no means neglect the spirits of the river and the mountain, they follow the methods of the Buddhist Laos near them.

Their villages are generally built by the water's edge, among the rustling areca and banana palms; the thatch-roofed houses reared high on piles and surrounded with stout palisades, inside of which some sugar-cane is growing. Close by on a higher knoll stands the white-walled monastery with its pretty steep-sloped roof, and the bells on the gables tinkling at evening in the wind are the only sounds heard, but the far-off thunder of the rapid, a weird air upon a flute, or a dog's bark among the cottages, and, as night advances, the distant note of a tiger prowling after deer, or the scared trumpet of an elephant.

Khache.—The simplest of all the people that we saw, however, were the Khamus* or Khache (or Katcha), as they are locally known. They wear nothing but a waist-cloth, a big hairpin in their long knotted hair, and silver earrings or a flower in their ears.

Their life is a hard one up upon the hillsides, the "*rai*" clearings being visible many miles climbing right to the hilltops. There they live, planting their rice and cotton, clearing and draining year by year with great labour large tracts of forest-clad mountain for their next crop. They are timid and shy in the extreme, a result of their treatment by the Lao, who, in the Nan and Luang Prabang territories on both sides the Mekong, have long looked on them as their slaves, to do what they liked with; and at the present time the Luang Prabang people depend on them and their industry for a great part of their rice. We found them gentle and docile as well as willing as porters, and, needless to say, they were fine men on the hills. Of the same race are the Lawas who live among the high ranges in Chieng Mai and Chieng Toong further west.

The Lao account for the present uncivilised condition of the Khache by a yarn which relates that the Lao and Khache were once brothers. Their father died, and left to be divided between them a box containing two bundles, and an elephant and her young one.

* First syllable pronounced Kar = slave.

It was agreed that the Khache should have first choice, and he took the smallest bundle, which lay at the top, and found therein the tiny waistcloth which he wears to this day, the Lao getting a fine *panung* (or dhobie cloth) which he has ever since adopted.

The Khache, not to be beaten thus, chose the biggest elephant, and took her away home with him. But she "grew sad in her heart, and her thoughts went towards her child," so she bolted away and returned to the baby, the Lao thus getting both. The Khache thereupon returned up into the hills in the sulks, and has ever since remained there, without clothes or elephants.

Sibsong Para.—Muang Sai is the least unimportant place in this district, and it is best known for its salt wells, which provide all the neighbouring country, its cotton, and its galena. From here there are tracks going south and west to Luang Prabang by Ban Lataen, seven days; south and east to Pak Beng, the mouth of the torrent known as Nam Beng, eight days; and to Chieng Kong, ten days; northward to Muang Kwa on the Nam Oo, three days; and thence to Muang Wa and the land of the poppy; and westward to Muang La on the Nam La.

The Buffer State.—Following down the Mekong meanwhile, from Chieng Sen we fall some 200 feet to Luang Prabang in the rapids already mentioned, which are situated at the beginning of the corners seen on the map.

It is below Chieng Kong that the more serious rapids come in, after passing the Nam Ta, which there forms the boundary between the Luang Prabang and Chieng Kong or Nan Trans-Mekong territory. What is to be the fate of the Nan territory on that side is no doubt one of the questions to be made out by the Boundary Commission, as the whole of that district has gone *primâ facie* under French rule together with the Sibsong Para.

The Buffer State or neutral zone is to be created between the British Shân States on the west and the French territory on the other; but then comes the question, Out of whose property is it to be carved? It is said that the contribution of France toward the neutral zone will be the Trans-Mekong territory which belonged to Chieng Kong; in other words, that she will remain east of the Nam Ta. Chieng Kheng was under Chieng Toong, which is now British, until Britain permitted it to go to Siam.

Is France to be allowed to seize this State too, and so seating herself, armed with her protective tariffs, on the Mekong left bank right up to the Yunnan frontier, be able to prevent English trade from ever getting over the river into Sumao and Yunnan? The estimates made of the commercial value of Yunnan may have been over-rated, but it is yet a doorway which England can little afford to have shut against her by another nation with such exclusive ideas about trade. The solution is that Chieng Kheng should be included in the neutral zone.

Forests.—At Chieng Kong a considerable deposit of sapphire-bearing gravel exists, at present worked by a body of Tongsoo British subjects. Below that we pass some Lu settlements, and then entering deep gorges are in a land where the Khache reigns alone upon the steep hillsides, in company with the tiger and the deer. Upon the highest points the pine remains the last relic of the northern scenery the Mekong has come through, and below among the limestone hills are the dense dark forests known by the name of *dong*, which are dreaded for their fevers all over Siam.

The largest timber in these is generally the Ton-takien, from which the long dug-outs are made, and the Ton-yang and others of the *Dipterocarpus* family, the Ton-yang being the source of the dammar oil, which is much used by the jungle men. It is a magnificent tree, with a gradually tapering stem, showing not a branch upon it for 100 to 150 feet from the giant buttresses which form its roots. Near a village it is generally disfigured, and after four or five years killed outright, by the cutting of pockets round its base about three feet from the ground for the collection of the oil. Magnificent orchids and heart's tongue-like ferns cling to them far up in the gloom, and the long arms of rattans and innumerable creepers drape them in their folds. Beautiful as they are, a few hours' march in these *dongs*, with no sign of sun or wind and only a chill damp in the air, soon deprives a party of its spirits, and makes one gasp to get out of their dismal depths again and into the sun, be it ever so hot. What they are in the rainy season I will not attempt to describe, but many a poor fellow has stalked in hale and hearty, and been left by his comrades dead in the track after a few hours' struggle with the raging fever.

As a rule Europeans seem to stand it better than the others, who, poor things, with their upbringing on a none too hearty diet of rice and salt fish, often collapse in a heart-breaking way.

Rapids.—Shooting rapids is not very exciting work taken altogether unless you be the helmsman, as one hardly feels the pace unless a head wind is blowing; for it is tolerably certain that the mound of water piled against an obstructing rock will knock your boat clear provided she is kept properly on her course.

Out of some thirteen rapids, which go to make the series already spoken of between Chieng Sen and Luang Prabang, Keng* Haow, Keng La, Keng Teu, and Keng Lang Luang are really dangerous owing to the huge eddies and whirlpools which keep breaking promiscuously in different places, and which, when they lay hold of a boat, spin her about in all directions, notwithstanding all the helmsman and bow-oar man can do to keep her straight. Bound with bamboos along their gunwales the boats are very stable; and as long as they do not get smashed upon the rocks by these eddies, a ducking is as a rule the worst that befalls going down river. Going up, when the boats are lightened for pulling against stream the easier, accidents are more frequent. The rapids are the same in character as those below Luang Prabang; there is a slightly smaller volume of water, but they are not the less awkward on that account. As a rule there is a village every 10 to 20 miles, and as one goes down one gets new crews who know the rapids of their section, the others returning home.

Pulling three or four oars, we used, in order to get over the quiet hot reaches, to get up races; but the Lao are not good oarsmen for racing, as they get into what rowing men know as a "bucket," pull very short, and are soon blown. By going stroke, and making them

* Keng in Siamese = rapid.

lengthen out, you could make any crew go right away from the others, to the huge surprise and delight of the whole gang, who seemed to imagine that rowing was an unknown art off the Mekong.

Luang Prabang.—At Luang Prabang we are among a Lao people differing in many ways from those of Nan. They smoke opium a great deal and occasionally drink; and though able authorities would say they should not be the worse for that, they are distinctly not the men the Laos on Nan are, either for grit and energy or purity and honesty. The guard I had with me were a set of the most useless, opium-smoking, good-for-nothings I ever had the misfortune to see, and in Luang Prabang they found themselves quite at home, while in Nan they had been looked on with considerable contempt.

I had heard so much of Luang Prabang—"Muang Luang," as they call it—that I was disappointed with it, its plain, its trade, and its people, and I should only care to return thither for one thing, and that to hear again the soft tones of the *kans* (or *khens*) drifting weirdly across the hot night air. The *kan* is a hand reed organ, with small mouthpiece and air chamber and fourteen bamboo reeds. It is the sweetest-toned little imitation of the choir organ that ever piped. Every man in the place has one and loves it, and carries it everywhere; and by the hour he will sit fingering out the quick march music or drawling the wail of a love song.

Away to the east the French have now gotten to themselves a country of mountain and valley, more cut up than that of the Sibsong Pana, and it remains to be seen what they will find to do with it. Nobody knows much about it excepting Messrs. McCarthy and Smiles, of the Siamese Survey, who have carried the triangulation right through it, and have been known to and lived for years among its peoples.

Three large streams come into the Mekong on the left bank at this point—the Nam Oo, Nam Sooung, and Nam Kan—and all are navigable for small dug-outs to the small, scattered villages among them.

It is among the confused mountain masses above them that the Meos are in most force, and until last year that whole country was under Siam up to the watershed, on this side of which no Annamite—much less the Annamite influence one has heard talked of—was ever seen, both Lao and Annamite cordially hating one another, and giving each other a wide berth.

As evidence of the influence of Siamese rule, I can only quote what I saw and heard; and it was certainly striking with what profound respect they spoke of the king and Bangkok, and a journey to Krung Tape, as they call the capital, in some capacity or other was looked on as a kind of finish to a man's education, while they always spoke of their cousins, the Siamese.

All this was when the work of the survey was in full swing. A popular and really energetic commissioner was stationed there, and no dream of coming changes was in the air, much less wished for.

In the rains the small plain in which the town stands is a sea of water, and in the dry season is parched and hot as a furnace down there among its hills, the atmosphere laden with smoke from the Khache fires destroying whole miles of forest for their rice and cotton crops, and the sun, a big red ball, blazing through the haze, which forms a peculiarity of the whole country between the 19th and 22nd parallels in February, March, and April.

Luang Prabang owned a considerable territory on the right bank opposite the town, and signs are not wanting to show that the French, notwithstanding that their original claims only reached to the left bank of the river, are now inclined to claim beyond that line. Should they be consistent they would have, for the Cis-Mekong Luang Prabang territory, to give back to Siam the Trans-Mekong territory belonging to Muang Nan, and Bassac on the Middle River. Of this at present there are no indications.

Southward.—The great southerly reach from Luang Prabang to Chieng Kan is very poorly peopled. The hills become low and retiring, and the bamboo nods its head more frequently on flatter ground. But the rapids are by no means done with, and there is a long series of them, of which the finest to the eye and ear is Keng Luang, or the great rapid. Below this the only habitations, besides those of the leopard, crocodile, and heron among the reeds, are one or two small villages, the most important of which is Paklai. This formerly was the place of embarkation for officials going up to Luang Prabang from Bangkok, the track coming over from Pechai on the Meinam, up the valley of the Nam Pat. On the water parting northward are teak forests, for which, so far, no outlet has been found.

Not 150 miles from Luang Prabang, Paklai is about a fortnight off by boat, which gives a very fair idea of the slow rate of travel usual in these countries.

Marches.—The rivers are the quickest roads, as a rule, even going up stream, and when it comes to marching, especially on the hill trails, where every man goes, dhâp in hand, lopping and cutting as he thrusts his way through behind the leader, the distances traversed must seem ludicrously small to those who are accustomed to open country. Though one has covered 220 miles in eleven days, this is distinctly fast travelling for jungle work, and in the rains ninety miles has taken one a day longer than that.

If one goes by Lao reckonings, great and wondrous sometimes are the results, for Lao distances depend on the digestion of the speaker, the aim he has in view, and other circumstances. Does a venerable Chow Muang (or district governor) find you to be a nuisance in his place with your curiosity and your questions, you will be astonished to hear what a short and an easy stage it is to your next stopping-place, where, too, there are said to be fowls, bananas, and rice galore to be had for the asking. So away you go light-hearted for your one day's march, but at sunset, alas! you are in the jungle still two days from your goal, and you begin to suspect that the old gentleman has made a fool of you.

Elephant men and bullock-drivers generally contrive to get further and further away from the next village on the march, and at noon when you are—by your own reckoning—within two hours of it, up they come with long faces, saying that you have eight hours' march (about twenty miles), and no water before you. You can then back yourself with safety to do ten miles an hour, for you are sure to be there within your two hours, and find a glorious cool stream alongside. With the exception of trifles of that sort, everyone is invariably most anxious to please; and so far does this carry the kind-hearted Lao that as you pound along the trail, asking him the name of this and that, he is contriving a most plausible scheme of names for every stream and brook and mountain you pass; and only next day, if you go over them again from your notebook with someone else, will you find how far the good fellow was willing to perjure his soul simply to give you what he conceived was a pleasure to you. He knew you wanted names, and would be annoyed if you couldn't get them. So he gave them you; you can't complain.

Muang Nan.—Across the watershed from Paklai, westward, lie a confused mass of forested hills, the highest points rising to 3,000 and 4,000 feet, full of game, and teak and other fine timber, and but sparsely inhabited by the temperate Nan men and their elephants. In fact, if you are searching for a model State, you will find about the nearest thing to it among those hills, where no thieving or violence are ever dreamed of, opium is not allowed, and the chaws (or chiefs) are imbued with the extraordinary and primitive notion that the chief must be a leader in deed as well as in name, and must be an example to his people for good; that if opium-smoking is not permitted to the people, the chief himself were better dead than infringing against that law. In all the villages, even the most remote, you will find a tidy sălâ (or rest-house) kept in excellent order for the passing traveller. You will have a large audience of women and jolly children come to meet you with cocoanuts, and when the men and lads return at evening a gang of them will come and sit round the fire, the chill night through, to guard you that no evil befall while in their village; and any time you wake you may see them squatting or lying round the blaze, wrapped from the heavy dew in their long red and white cloaks, and hear their low talk and gentle laugh. No Nan Lao ever talks five minutes without a laugh thrown in, and quarrelling and hard words are beneath him, and moreover are ill for merit-making, as he learned when a pupil in the monastery hard by.

His ideas of wealth and prosperity are a buxom wife (even though she be afflicted with goitre), some hardy boys to help him in the jungle, an elephant or two, and a dug-out in the stream. In the forest his only needs are his long curved dhâp, his cloak, and flint and steel, with a handful or so of hill rice, and a little sugar-cane and tobacco in his bag.

Elephants.—As the camel in the desert, and the dog upon the icefloe, so the elephant is indispensable in the forest of Nan, whether for hauling teak, carrying cotton or tobacco down to Nan, or bringing home the jungle produce. And naturally enough round every Lao fire he forms, with the tiger and the *pi*, or spirits of the mountain, the hero of many a camp yarn.

Monhot (and Colquhoun copies him) says that they never carry more than 250 to 300 lb.; but three to four *picul* is nearer the mark (400 to 500 lb.), and for short journeys rather more, the average pace not exceeding two and a-half miles an hour for a day's march on the hill trails, which are often very rough for any beast of burden. They differ very much in gait, the big teak-hauling elephant having a regular jack-tar roll, which is not pleasant for many hours' ride, and is indeed more bearable in the mahout's place upon the neck. A hill elephant, accustomed to light weights and steep climbing, is much quicker and easier in motion; but the ideal to ride is a four-year-old, who, to keep up with his longer limbed mates, has to maintain a rapid stride. At this age, however, he is usually frolicsome, and as yet inclined to try conclusions with the mahout, which usually ends in a good deal of shrieking and trumpeting as he finds himself worsted and bleeding about the head, while the older ones look on contemptuously with an occasional wink of one eye, as much as to say, "He is young and foolish, and will soon learn better."

The babies are just like other babies all the world round; playing and rolling on the ground, getting in everybody's way, gamboling and making faces, and finally sulking and shrieking for mamma, which cry, be sure, is never in vain, and up tears the hearty dame of seventy or eighty summers at all speed, regardless of all obstruction and the mahout's indignation, to caress her beloved brat with her trunk; and the urchin is all right again in two minutes, and off to join the other babies, regardless of mamma's objections.

They say—though I will not vouch for it—that the short, tuftless tails and jagged ears so often seen in otherwise good-looking elephants are caused by their mothers, who bite them (as we do terrier pups' ears and tails) at an early age, and it is supposed to make them fierce.

Many are captured from the wild herds, and trained, but such escaping again are generally reckoned to be particularly vicious. The "rogue" is as a rule nothing more than an ungentlemanly individual who has been turned out of the herd for some breach of etiquette, and becomes soured and ill-tempered from want of the restraining influences of good society, for the herd is most rigorous in its decorum and regular in its methods.

It sleeps from daylight to 1 or 2 p.m., and waters and feeds at night; it never crosses a stream but at the traditional ford at which its grandfathers and grandmothers always crossed 150 years ago; and so important a matter is this regarded that even a wounded elephant will not so far forget himself as to charge his assailant in the water unless the latter has inadvertently stationed himself at one of such customary fords. Do elephants get blacker with age? The blackest elephants I ever travelled with were fine tuskers over eighty years old, and the lightest was a young spark of six, who liked a good dinner, and had a way of breaking into enclosures and stealing bananas, jackfruit, sugar-cane, &c., to the tune of a hundredweight at a time. His punishment was to put him to stand in the sun near a succulent bamboo which he was forbidden to touch. He strewed dust on his head and back to keep cool, and looked infinitely bored standing there on three legs and coiling and uncoiling his trunk.

The Lao of Nan often wear a bit of turban, like the Lus, tied round the central tuft of hair, while the Luang Prabang men usually leave the shaved head and central tuft unadorned. The women, unlike the Siamese, always keep their hair long, with often a flower cunningly displayed in the knot upon their heads.

Chieng Kan.—At Chieng Kan, however, where a fair number of Tongsoos from Burmah have settled, the women cut their hair short, and it begins to be evident we are getting nearer the influences of Bangkok. Here the Nam Loey comes in from the south, from the township, a cluster of villages, of the same name.

Further south lies the valley of the Nam Sâk flowing into the Meinam—a kind of border-land between Siam proper and the Lao people, and consequently pretty full of cattle-lifters, elephant-stealers, and the like. It is a region rich in mineral—from scanty gold in the Mekong sands and alluvial gravels to massive deposits of hæmatite, lodes of galena, tellurium, bismuth, and other minerals, which cannot be got at to any purpose until communications are improved.

Below Chieng Kan there is a series of difficult rapids with which the river starts on its course eastward to Nongkhai. In places are huge bays carved out by the swirling eddies from the dark slate rocks, which tower aloft 30 or 40 feet in the low-water season, and are submerged by the rushing brown surface in the floods. Often the river is not 200 feet wide, a cauldron of seething whirlpools, with no bottom at 20 fathoms, and for a quarter of a mile on each side above the rocks stretch the hot banks of blown sand, with deep pools among them, over which in flood-time the waters can find an exit; then the Lao boats creep up along the banks close beneath the trees, and far from the tearing current in the centre. The banks are hilly and covered with fine forests; and, as further north when the time comes, will yield endless valuable heavy woods and dyes, of which the present scanty population can use but little.

Wieng Chan.—As the river turns more south toward Nongkhai it opens out in wide spaces of still water, which, at the great expanse of Ang Pla Bük, is over a mile across, and a famous breeding-ground for the fish (said to be a sturgeon) of that name.

Below, on the left bank, lies Wieng Chan, the old capital of a formerly powerful Lao State, which was destroyed in 1827 by the Siamese. Though long ago in ruins, it is the centre of a number of thriving villages, which have every appearance of prosperity. The French, now they possess that bank, could not do better than make it once more the head-quarters of the surrounding country, so advantageously situated is it, and so full of association to the Lao mind.

Southward, again, in wide placid reaches, winds the Mekong, here some 500 feet below its level at Luang Prabang. Though subject to fits of violence in the squalls of March and April, it is on the whole tamed for a long distance in its course. Hence to Kemmarat steamers will be able to ply, and find fairly deep water all the year, and a comparative immunity from rapids; but I am inclined to think that Nongkhai is more likely to feed through Bangkok than they to feed Nongkhai.

Nongkhai.—This town is the Siamese administrative and commercial centre of the Eastern Lao States, and the middle Mekong region. To the southward stretches the flat expanse of the Korat Plateau, at a mean height of about 600 feet above sea-level; a plain of salt-fields and extensive swamps, draining for the most part into the Nam Moon and its tributaries. Between the swamps and salt districts lie the open jungles known as *kok*, productive, so far as my experience goes, of little else but hard-woods, thirst, and heat.

Trade.—The whole of the trade of this region is in the hands of 1,000 or so of Chinese, living chiefly in Korat and Nongkhai; the Eastern Lao, distinguished from our northern friends by their absence of tattooing, as well as their methods of life, never having been very enterprising. It is only lately, and for the first time, that they, like the majority of the Siamese, have begun to understand and feel the want of luxuries before unknown to them, and, therefore, of money to buy them with. As this grows upon them they will be more likely to be industrious, especially if, as is being done here and there, the "screwing" of the official class is to some extent lessened or removed.

It is this which has kept down the energies of the Siamese as a nation, and has made them so careless of trying to realise comfort or affluence. And it is by removal of this, and the modification of the rigorous covée system only, that the Siamese can ever compete on equal terms with Chinamen and other foreigners, who are comparatively unharassed. Roads are wanted to feed the Bangkok-Korat line, with bridges over the many deep streams crossing the main lines of communication between Korat and Nongkhai, Korat and Nong Han, and Korat and Ubon and Bassac.

As far as the trade goes, any schemes for railways beyond Korat are premature, and what are wanted are simply a few facilities for the ox-cart traffic, which is quite sufficient for its purpose even now, when, owing to the state of the jungle trails in the wet weather, travelling is practically suspended for four months in the year.

What has been wanted badly for the whole plateau has been a way of exit, the Dong Phya Yen forest having been a serious obstacle to communication with Siam and the outer world, forming, as it does, a thick belt of fever-stricken forest all round it on the south and west. Such an exit the Bangkok-Korat Railway will now afford.

The clause forced by France on Siam, by which the latter shall keep no armed men at all within 25 kilometres of the Mekong, is likely to be a source of much trial to the latter; for in such a no-man's-land the bad characters will inevitably gather together, and the more important settlements, which are upon the riverside, will be defenceless against them.

Another difficulty the riverside Lao have to face is that in many cases they live upon the right bank, while owning paddy land and feeding their elephants in the better feeding-grounds upon the French side. If they elect to stay upon the right bank, they find themselves with no protection or evidence of government within 25 kilometres; while on the left bank is their property, and the visible and tangible protection afforded by officials who will certainly not be hid away back in the jungle out of touch with the river highway. If the aim of France had been to depopulate the right bank, and to raise endless difficulties and disputes in the future, no better means could have been found than the insertion of that clause.

The coinage on the Middle Mekong is usually the Siamese *tical* and its subdivisions, which has taken the place of older money, such as the boat-like bars of Bassac.

In Nan and the north, on the other hand, the Siamese coinage is still rare, the rupee and the anna, with the head of the Empress of India, being seen everywhere.

In many of the hill villages barter was the only method of exchange. Now, however, we may expect that French money will spread, at least over the Sibsong Para.


THE
MEKONG
RIVER
and neighbouring river systems
compiled from various sources
BY H.W. SMYTH
SCALE
English Miles
copyright
TIBET
CHINESE TERRITORY
CHINA
SZE-CHWAN
YUNNAN
KWANG SI
WESTERN CHINA
BURMA
SHAN STATES
LAO STATES
SIAM
ANNAM
TONGKING
CAMBODIA
COCHIN CHINA
GULF OF TONG-KING
GULF OF SIAM
BAY OF BENGAL
GULF OF MARTABAN
MALAY PENINSULA
Mergui Archipelago
MANDALAY
BANGKOK
LUANG PRABANG
PNOMPENH
SAIGON
HANOI
Rangoon
Moulmein
MEKONG RIVER

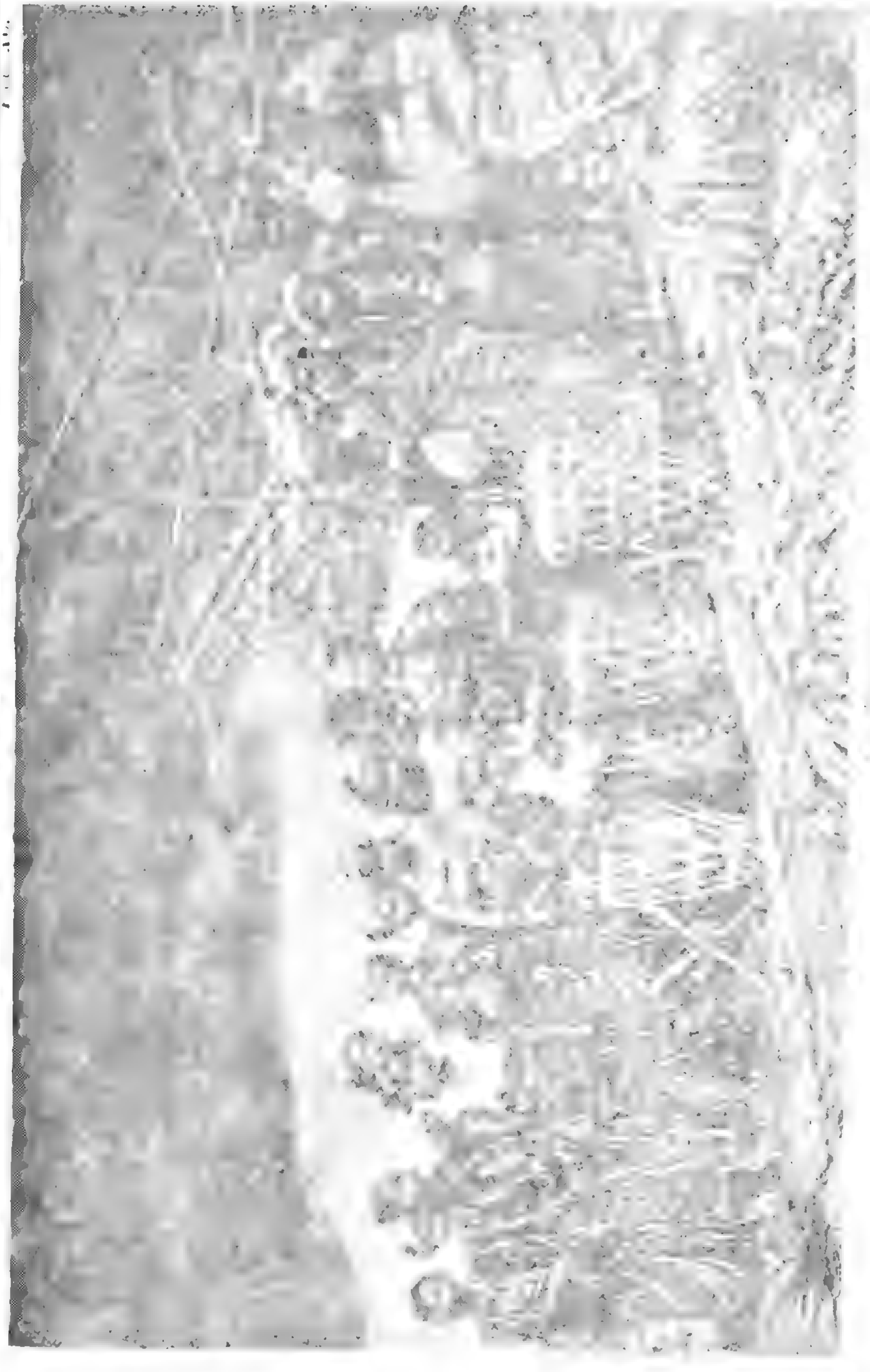
Plate LXXXVII.

A view on the Nam Oo.

Plate LXXXVIII.

Rock Barriers on the Nam Oo

Rock Monastery on the Nam Oo.



A Township on the Nam Oo.

An evening camp in the Salt Districts, Korat Plateau.

LMG

A Lu Monastery and Village Mekong.

A Lao boat on the Mekong, shewing bamboo floats lashed along the sides for shooting rapids, shelter, steersman's platform &c.

J M B

In the swamps of the Korat Plateau.

A sketch on the march to Ban Tanoon, hill ranges, north of the Mekong, from the watershed.

The plain is a great cattle-rearing country, and to this most of the rather small energies of the people are devoted. Elephants are scarce, and ox-carts take their place. Dacoity was, and in many parts still is, to the misery of the poor villagers, fairly common; and generally we find ourselves in a new country where all the conditions of life differ entirely from those we have been considering on the Upper Mekong. Along the river side for years past the French Roman Catholic priests have been paving the way for the political power of France, with that unostentatious energy for which they are famed.

We shall soon be in better position to judge, now that power has come in, whether the trade lines of the Middle Mekong will follow the French routes from Annam or Saigon, or the mastery will be maintained by the Bangkok-Korat route, by which nearly all European goods have hitherto passed up into the plateau, and along which the railway is being rapidly advanced. We may be certain that the French will leave no stone unturned to ensure the former, be the value of the trade large as the French hope, or small as I myself confess to thinking it as it stands at present.

In the race for the Upper Mekong and Southern China the French have got the start, and England by her inactivity is allowing that start to get longer every day, until it begins to look to the spectator as if she thought she were not interested in the event.

I say nothing of the aspect of things in Bangkok, as that brings us on to the verge of politics; but I repeat that if England does not begin more seriously to look at the question of routes into the northern Mekong valley, and to take some action in that direction, she will find the French will have won the prize, through their new acquisitions and the Sibsong Para, over which they are already roving, before she is half-way over the course.

I have cast doubts, which I believe to be well founded, on the present extent of the trade which both England and France are reaching after in those regions; but, as a matter of fact, it is an unknown quantity, and a few years may completely alter its aspect.

For England to give it up and allow France to "row over" would be an act more far-reaching than it appears; it would fatally injure her prestige in Asia, and would put completely into French hands a possible market which she can ill afford to lose.

NOTE ON NAMES IN MAP OF MEKONG.

Siamese.	*Lao.*	*English.*	*Tibetan.*	*Chinese.*
M=Muang	Chieng	Town		
Ban	Ban	Village		
Nam	Nam	River	Chu	Kiang
	Hoay	Mountain stream		
Menam or Mei	Menam	Large river		
Klong		Stream or canal		
Nong	Nong	Swamp		
Kao	Doi or Phoo	Mountain		
Wat	Wat	Monastery	Gomba	
Sala	Sala	Rest-house		

N.B.—The pronunciation of *a* is long, as *ar*, *e.g.*—

Nam (or river)	pronounce	Narm.
Luang Prabang	,,	Luang Prabarng
Muang Nan	,,	Muang Narn.
Lao	,,	Lar-o.
Shân	,,	Sharn, &c., &c., &c.

5.—THE HIMALAYAN STATE OF SIKHIM.

Communicated by Hon. A. W. PAUL, C.I.E.

GENERAL SKETCH.

On the northern border of the British district of Darjeeling the main chain of the Himalaya throws out to the southward two enormous spurs—the Singilela and Chola ranges. These almost impassable barriers enclose three sides of a gigantic amphitheatre, hewn, as it were, out of the Himalaya, and sloping down at its southern or open side towards the plains of India. The tracts of mountainous country thus shut in consist of a tangled series of interlacing ridges, rising range above range to the foot of the wall of high peaks and passes which marks the "abode of snow" and its offshoots. The steps of this amphitheatre make up the territory known as Independent Sikhim (from Sukhim, a new house). The encircling wall of peaks and passes forms on the north and east the frontier of Tibet, while on the west and south-west it divides Sikhim and Darjeeling from Nepal, and the Dichu forms the boundary between Sikhim and Bhutan. With the northern hills all intercourse is cut off during five months of the year, and the highlanders dwell apart except for occasional visits of Tibetan traders over the Kangralama Pass. The area of the State is 2,818 square miles.

INHABITANTS.

The aborigines of Sikhim are known to the British as Lepchas, but style themselves Rong-pa, or ravine-folk. Their physical characteristics stamp them as members of the Mongolian race, and certain peculiarities of language and religion render it probable that the tribe is a very ancient colony from Southern Tibet. They are above all things woodmen of the woods, knowing the ways of birds and beasts, and possessing an extensive botanical nomenclature of their own. Of late years, as the hills have been stripped of their timber by the European tea-planters and the pushing Nepalese agriculturist, while the Forest Department has set its face against primitive methods of cultivation, the tribe is on the way to being pushed out. The cause of their decline is obscure. There is no lack of employment for them; labour is badly wanted and well paid; and the other races of the Darjeeling hills have flourished exceedingly since European enterprise and capital have made the cultivation of tea the leading industry of the district. The Lepchas alone seem to doubt whether life is worth living under the shadow of advancing civilisation, and there can, we fear, be little question that this interesting and attractive race will soon go the way of the forest which they believe to be their original home. Next in importance of numbers to the Lepchas are the Bhuteas from the Tibetan province of Khams, and the Limbas from the Tibetan province of Tsang. These, like the Lepchas, are all of Mongolian race; they recognise the spiritual authority of the Delai Lama of Lhassa, and are in great fear of Tibetan power. The Newars and Goorkhas of Nepal, professing the Brahminical faith, have nothing to attract them towards Tibet, and they may be relied upon by the British authorities, with whom their interests are identical.

MODERN HISTORY.

Legends inform us that three monks of the red-hat party, flying from persecution in Tibet, met in one of the lonely Sikhim valleys. They sent for an influential Tibetan to represent the civil power, and set about the conversion of the Lepchas. Success attended them, and their friend became Raja of the whole country. Monasteries and churches rose to preserve the memory of the missionary monks, and the descendants of the Tibetan settlers are recognised to this day as the rightful rulers of the country. The external policy of the petty princedom thus formed was determined by the manner of its creation. In the East religion is still a power, and all things take their colouring from the faith of the ruler. The chief of a barbarous tribe raised to power by the ingenuity of Tibetan monks must needs, in default of stronger influence, acknowledge the religious and political predominance of the rulers of Tibet. As the craving for ritual revived, and the hostility between the rival sects showed signs of abating, the religious and political bonds linking Sikhim with Tibet began to be drawn tighter. Doubtful questions of discipline and procedure were referred to Lhassa for the decision of the Dalai Lama, and his mandate was virtually, if not statedly, admitted to be the final appellate authority for Sikhim Buddhists. Wool, tea, silk, all the comforts and ornaments of life, came to them from Tibet, while intercourse with other countries was difficult. Small wonder, then, that their continual effort was to show themselves to be thorough Tibetans, that the Tibetan language came into use as their Court speech, and that their chief advisers were drawn from Tibetan monasteries. In course of time this connection grew to be closer, and the last three Rajas have married Tibetan wives, and have held landed property and owned herds of cattle in Tibet. Such marriage introduced a new and important factor into Sikhim politics. Women brought up in the dry, keen air of Tibet could not stand the moist warmth of the lower Sikhim hills, drenched by the immoderate rainfall which prevails on the southern slopes of the eastern Himalayas. Their influence, coupled with the Tibetan proclivities of their husbands, induced the Rajas to transfer the head-quarters of their government to the valley of Chumbi, one march on the Tibetan side of the Jelap Pass. The prolonged residence of the chief in Tibetan territory had the worst possible effect on the internal administration of the State. Abuses of all kinds sprung up, while redress was hard to obtain. Lepcha interests were neglected, and Chumbi became the Hanover of Sikhim.

Meanwhile a still greater power was being compelled, in spite of itself, to enter the field of East Himalayan politics. For thirty years the bigoted and warlike Goorkhas of Nepal had been harrying their peaceful Buddhist neighbours with cattle-lifting and slave-taking incursions. Before the year 1814 they had conquered and annexed the foot hills or Terai, now covered by the valuable tea-gardens of Darjeeling. But for our intervention they would probably have permanently turned the whole of Sikhim and the hills south and west of the Tista into a province of Nepal. Peace had to be kept on the frontier, and the Government of India was the only power willing or able to keep it. At the close, therefore, of the Goorkha war, in 1817, we restored the Terai to Sikhim, and our title to exercise a predominant influence in that State has remained undisputed for seventy years, until recently challenged by the monastic party in Tibet.

Following our traditional policy, we meddled as little as possible in the affairs of Sikhim, and no further negotiations took place until 1834, when certain Lepcha malcontents, who had sought refuge in Nepal, made a raid on the tract ceded in 1817. Under pressure from us the refugees returned to Nepal, and the opportunity was taken by the Government of India to procure from the Raja of Sikhim the cession of the hill-station of Darjeeling, and a small tract immediately surrounding it. Fifteen years afterwards Dr. Campbell, the Superintendent of Darjeeling, and Dr. (now Sir Joseph) Hooker, while travelling in Sikhim with the permission of the British Government and the Raja, were seized and imprisoned by the Diwan, or Prime Minister, of Sikhim. This treachery was punished by the annexation of the entire Terai, and a large area of the middle hills. The feeling, however, continued; criminals were harboured in Sikhim, and British subjects were kidnapped from our own territory for the purposes of the slave trade between Sikhim and Bhutan.

Having exhausted all ordinary forms of protest, the Government of India found it necessary in 1860-1 to order the occupation of Sikhim by a force under Colonel Gawler. Our troops advanced to the Tista, the Raja accepted the terms offered, and in March, 1861, a treaty was concluded at Tumlong, the capital of Sikhim, which regulates our relations with the State up to the present day. Its chief provisions are the following:—"Criminals, defaulters, and other delinquents are to be seized and given up on demand, and may be followed by our police. Trade monopolies, restrictions on the movements of travellers, and duties on goods passing between Sikhim and British territory are abolished. Power is given to the British Government to make a road through Sikhim, and the Sikhim Government covenants to protect the working parties, to maintain the road in repair, and to erect and maintain suitable rest-houses for travellers. The slave trade is prohibited. Our suzerainty in questions of foreign policy is recognised, and Sikhim undertakes not to cede or lease any portion of its territory, or to permit the passage of troops without our consent." Finally, the Raja "agrees to remove the seat of his government from Tibet to Sikhim, and reside there for nine months in the year." No more complete recognition of our supremacy could well be demanded.

No difficulty was experienced in carrying out the terms of the treaty of 1861. Europeans travelling in Sikhim were cordially received by the lamas and people; surveys were commenced without hindrance; criminals were surrendered by the Sikhimese, or captured with their consent by the police of Darjeeling; freer intercourse with Darjeeling brought about the extinction of slavery, and many British subjects acquired property in Sikhim and held office under the Government of that country. But in the winter of 1873-4 the Deputy Commissioner of Darjeeling visited Sikhim and the Tibetan frontier to advise on the making of a road to the border for purposes of trade. Tibetans and Chinese were at once in arms, and the Chinese Ampa or Resident of Lhassa wrote to the Raja in the name of the Emperor of China, reminding him that he was bound to prevent the "Peling sahibs" (or

Europeans) from crossing the frontier of Tibet, and warning him that, if he continued to make roads for the sahibs through Sikhim, "it would not be well for him." The following year there was a dispute as to the succession, when the British Government placed its nominee, the nearest heir, on the throne.

All went well until in 1886 Mr. Colman Macaulay was deputed to lead a mixed political, commercial, and scientific mission to Lhassa. Under pressure from China, with whom we were then delimitating the frontier of Burma, this mission was withdrawn. This forbearance was misunderstood by the monastic party in Tibet, who immediately assumed an aggressive attitude; and a body of Tibetan militia fortified themselves at Lingtu, twelve miles within the Sikhimese frontier. The Raja of Sikhim when called upon to visit Darjeeling to confer with the Lieutenant-Governor of Bengal replied, after many evasions, that he and his people, in 1886, had signed a treaty declaring that Sikhim *was subject only to China and Tibet.*

From the commencement of our relations with Sikhim there have been two parties in that State—one which may be called the Lepcha or national party, consistently friendly to our Government, and a foreign or Tibetan party, steadily hostile. The family of the Rajas has generally sided with the latter, partly in consequence of their habit of marrying Tibetan women, and partly through their residence at Chumbi. Of late years a further complication has been introduced by the settlement of colonies of Nepalese in parts of Sikhim—a measure favoured by the Lepchas generally. These settlers look to us for protection in case of danger, and are naturally friendly to our Government; but their presence is regarded with disfavour by many influential lamas, on account of difference in creeds and fear of them as a more warlike race.

The pressure from Tibet became more and more apparent, and at last the leaders of the Nepalese settlers declared plainly that the British authorities must either protect them or they must make terms with the Tibetan party. The Indian Government had to decide whether it should abandon Sikhim to possible anarchy, or interfere to prevent Tibetan encroachments. In the first case there would probably be a massacre of Nepalese settlers, followed by war between Nepal and Sikhim, the latter aided by Tibet; in the second case there was the fear of offending China, nor could it be overlooked that east and west of Sikhim lie the only really independent States of India, Bhutan and Nepal.

It has already been mentioned that the Tibetans had fortified and garrisoned a post at Lingtu, twelve miles south of the Sikhim-Tibetan frontier, and so had blocked the new trade road recently constructed to the important Jelap Pass. In March, 1888, General Graham entered Sikhim at the head of a small field force consisting of British, Sikh, and Goorkha regiments. A stockade below Lingtu was stormed, and the garrison at Lingtu fled before they were attacked. The British force entrenched at Gnatong, eight miles south of the Jelap Pass, and on the 22nd May they were attacked by the Tibetans in force, whom they repulsed with great slaughter. Forgetting the axiom in Asiatic warfare, that the first defeat of an enemy should be thorough and complete, our men were not encouraged to follow the flying enemy, and this mercy was mistaken for fear. A Tibetan force of 11,000 men was raised, and fortified a position on the frontier, 13,500 feet above the sea. A peak on their right flank was the key to the position, and when this was stormed by the Goorkhas their line was rolled up at leisure, and in retiring from such a difficult position one-tenth of their force fell. This unavoidably severe lesson was taken to heart by the Tibetans. The treaty that followed defined the frontier against Tibet, confirmed the suzerainty of the Empress of India over Sikhim, and reaffirmed the principles of the treaty of 1861 with regard to roads and trade.

MARRIAGE CUSTOMS.

The following are the principal marriage laws of Sikhim:—If the eldest brother takes a wife she is common to all the brothers. If the second brother takes a wife she is common to all the brothers younger than himself. The eldest brother is not allowed to cohabit with the wives of younger brothers. Three brothers may marry three sisters, and all the wives be in common; but this case does not often occur. The marriage ceremony consists almost entirely in feasting, which takes place after the usual presents have been given to the girl's relations. These presents constitute the woman's price, and vary in accordance with the circumstances of both parties. The only religious ceremony is performed by the village headman, who offers up a bowl of *marwa* to the gods, and, presenting a cup of the same *marwa* to the bride and bridegroom, blesses them, and hopes their marriage may be a fruitful one. The marriage tie is very slight, and can be dissolved at any time by either the man or the woman.

PRODUCTIONS.

Minerals are not abundant, or are little sought after; copper, iron, and lime being the most important. The crops are rice, millet, buckwheat, wheat, barley, sugar-cane, and Indian corn. The principal fruits are the orange, mango, peach, walnut, breadfruit, citron, lemon, guava, apple, pear, pomegranate, pineapple, and plantain; and of vegetables there are pumpkins, cucumbers, tomatoes, chillies, radishes, turnips, onions, garlic, ginger, and yams. Cattle, yaks, sheep, and goats are the principal domestic animals kept.

NATIVE VEGETATION.

Sir J. D. Hooker divides Sikhim into three zones. The lower, stretching from the lowest level up to 5,000 feet above the sea, he called the tropical zone; thence to 13,000 feet, the upper limit of tree vegetation, the temperate; and above, to the perpetual snow line at 16,000 feet, the alpine. In describing the aspect of the country, he says that up "to an elevation of 12,000 feet Sikhim is covered with a dense forest, only interrupted where village clearances have bared the slopes for the purpose of cultivation." At the present time, however, this description does not apply below 6,000 feet, the upper limit at which Indian corn ripens; for here, owing to increase of population, almost every suitable part has been cleared for cultivation, and trees remain only in the rocky ravines and on the steepest slopes.

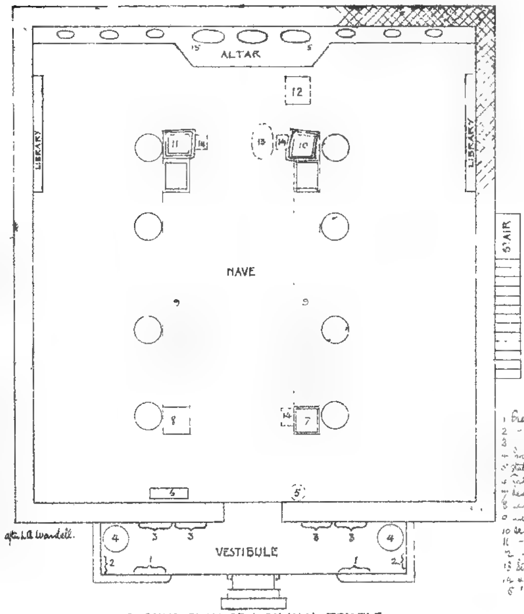
The forest consists of tall umbrageous trees, with little underwood on the drier slopes, but a luxuriant growth of shrubs along the gullies

Plate XCVII.

DIAGRAMS ILLUSTRATING PAPER ON THE HIMALAYAN STATE OF SIKHIM

BY

HON. A. W. PAUL C.I.E.

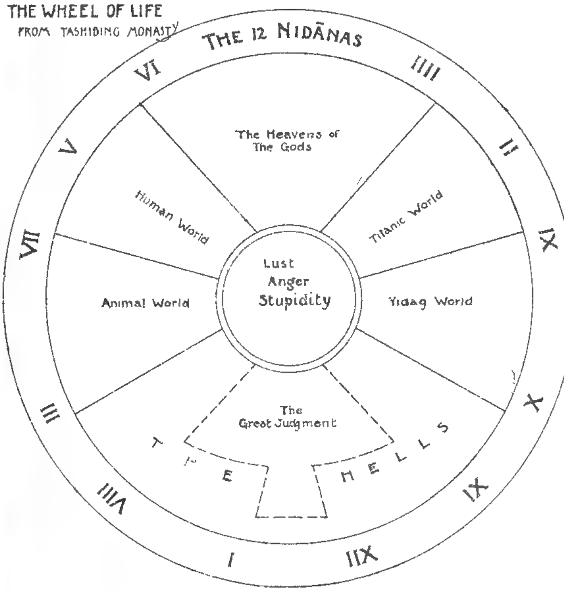


1 Fresco of Locality Lemon
2 – Ki-Kang Mar Hak [illegible]
3 [illegible]
4 [illegible]
5 [illegible] Chho-timba [illegible] Marshall
6 Table for Tea & Soup
7 [illegible] Chho-timba
8 [illegible]
9 [illegible]
10 [illegible]
11 – – [illegible] chief Celebrant
12 – [illegible]
13 Site where [illegible] figure of [illegible] is laid
14 [illegible] table
15 Idols

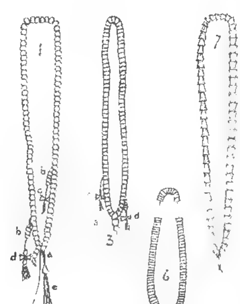
GROUND PLAN OF A SIKHIM TEMPLE

THE WHEEL OF LIFE

FROM TASHIDING MONASTY



LAMAIC ROSARIES



1 The yellow wood [illegible] of the Geluk-pa [illegible]
3 [illegible] Chinese [illegible]
6 Human skull [illegible] rosary
7 [illegible] rosary
a – [illegible]
b – Counters
c – [illegible] pendant
d – [illegible] pendant
e – [illegible]

and watercourses. Many of the trees are similar to those of the Queensland scrubs, as the figs. *Terminalia*, Myrtaceæ, Euphorbiaceæ, Meliaceæ, *Bauhinia*, *Calamus*, *Pothos*, *Cycas*, *Pandanus*, *Ardisia*, *Myrsine*, *Symplocos*. Shrubby Leguminosæ, as *Indigofera* and *Desmodium*, are as common as in North Queensland; but the monkshoods and larkspurs recall the European forests. *Lycopodiums* and *Selaginellas* are common; and the same families of ferns are represented as in tropical Australia, including the great fern of the North Queensland gullies, *Angiopteris evecta*; and the birds'-nest fern, *Asplenium nidus*. Orchids are showy and numerous, and most of the North Australian genera are represented; and many of your favourite garden plants, *Thunbergias*, *Beaumontias*, *Buddleias*, and *Hydrangeas*, have here their home.

6.—BUGANDA.*

By Rev. GEO. K. BASKERVILLE.

I have never before done such a thing as write a paper for more than very private occasions, and so I rather tremble; also my time is limited, and even now I fear that this will scarcely reach you in time. Dr. Wright, whom you mention in your letter, is no longer in the Buganda Mission; he had a serious illness, and was forbidden by doctors to return to Africa. He is now at Nablus, in Palestine, in charge of a hospital. People know so much about Buganda these days that it will be difficult to tell you anything new. I shall not attempt to write politics; they are odious things, and ours is only a most unwilling connection with them. Of course it is a comfort to have the Union Jack flying at Kampala, and to have an English resident—a vast improvement to the régime we found here when we arrived just three days later than Captain Lugard, of the I.B.E.A.† Company. Please do not think that I wish to pick to pieces what the officials of the company did in the country; some of them I have had a great liking for; but it was annoying to them to find that the native Christians would always consult their teachers on all points, which was only natural, and to be expected. I may say that for our part we did all we could to curb our people, teaching them that though perhaps slighted or snubbed here, yet their reward was before them.

The King is still the same old weathercock that he always has been. He is most intelligent, and seems to take an interest in being taught. I have not been resident in the capital for some time, and hence, I think, am better able to give you an idea of the state of religion, and what advance it has made in the country. Since I left Mengo in February of last year, I have moved about a great deal in the province of Kyagwe, which lies between Mengo and Basoga. Several of the chiefs were chiefs in Budu in the old days, the province west of Victoria Nyanza. The great majority of the peasants, however, are the same who were here before the war, and were born here. In the old days, when nothing was or could be done in the provinces, it was the chiefs and their boys and personal attendants who were reached, and of the chiefs some went and spent occasionally a short time teaching in their gardens, but not many. They had not learnt

* Commonly known as Uganda. † Imperial British East Africa.

to give out, and were all keen to take in. Then, again, only in the last two years have we had anything like a supply of books for sale. Here in Kyagwe the bulk of the readers are the people who came up from Budu after the wars. I doubt if amongst the 220 who have been baptised here (in Kyagwe) since we came in February, 1893, more than half-a-dozen are natives of Kyagwe. That some are beginning to be got hold of now, I do know. We have some seventeen little out-stations in our immediate vicinity, only a small branch of a regular system of teaching originated in the capital, in the beginning of this year, as the outcome of a remarkable time we had last December in Mengo.

Spiritual results have been great, but the greatest visible result is the fact that some 200 or so natives have gone out supported by the native Christian church to teach in the country districts and on the islands; besides this, to several of the neighbouring countries native missionaries have been sent out. These men when they go are given nine yards of calico, one sleeping mat, and one bark cloth for a night covering: also a New Testament if they have not one already; total expense under £1. This lasts them for three months, when some who are near the capital come back to be taught, and others go in their places; but others who have been sent to more distant places stay a second term of three months, and then get six months' instruction. Anyone sending £3 a year will have the joy of knowing he has a representative in the mission field. Surely many of you might well have many at such a low figure. At the majority of places where these people have gone the residents have built a church and house (for the teachers). The native Christians have at last begun to realise that if they wish their country to be christianised they must put their shoulders to the wheel, and they are doing it. It is surprising to see the vivifying power of the Spirit of God in some of these people, who are naturally so terribly lazy and idle.

Let me pass to another subject. Horses are a late introduction here, and are readily bought by the big chiefs for six or seven frasula (35 lb. weight) of ivory. There is a wish also to make carts for transport. This will be a great advance, and will naturally lead to the improvement of the roads. The Baganda have a good notion of bridging a marsh with logs and stakes. Such a bridge, with earth beaten on top, lasts for a twelvemonth. One or two of the wealthier chiefs have given up drinking the native plantain beer, and now take tea. This has led to the potters attempting to copy English cups, and very good attempts they have made. Chairs have long been in use, but now many are making tables, not as yet to use for eating at, but for writing on. A great amount of stationery has been sold lately—paper, pens, ink and pencils, copy-books of blank paper, also note-books of all sizes, and inkpots.

The jigger has been for more than two years a great plague. I believe its importation here must be attributed to caravans from Congo regions, possibly Stanley's; thus it found its way to Tanganyika, and gradually worked up here. The insect generally attacks the feet; and one female lays upwards of 300 eggs, which in their turn propagate if not extracted. It resembles a flea, but I need not dilate on the jigger to a scientific association. Uncleanliness is the chief cause which favours its propagation, and neglectfulness—not examining the feet daily.

Mortification sets in, and the patient dies from blood-poisoning. I should say antiseptic treatment generally is successful. Hence, you see, a box of antiseptic medicine would be a most valuable help to us. Of course there is always a means of help in sending a cheque to the Bible Society to cover cost and carriage of a load of books to be consigned either to the secretary or to some special missionary for judicious distribution amongst the poor.

Our Sunday is over here as I write. In one small temporary church we have had a crowd-out it is generally so. I divided the services with the Rev. Nickodemo Sebwato, who, being a chief, was ordained by the bishop as a perpetual deacon last year. This afternoon he preached a capital sermon on "Oh, Jerusalem, Jerusalem, thou that killest the prophets!" The other native clergyman stationed here has been away to-day at one of our out-stations; he looks forward to taking priest's orders when the bishop returns from the coast. We have full prayer-book services on Sundays, with exception of the Psalms, which we have not got yet in print. We have the whole New Testament; and towards the Old Testament, Genesis, Exodus, Psalms, Joshua, and Daniel have gone home. All these should reach us with the bishop at Christmas. After the morning service here on Sundays, we have a congregational prayer meeting, at which anyone prays; it is quite informal. Week-day teaching goes on till 9 a.m. from an early hour, and then we have a short service which I take in turns for a week with the deacons. At this we go straight through the Gospels, expounding a short portion; this, with a hymn, creed, confession, and collects, lasts half-an-hour. After this come classes. At present I am having a Bible class in Hebrews for the next hour, and then confirmation and baptism classes. All the baptism candidates first learn a short catechism, and none are enrolled as candidates before they have mastered it thoroughly; then one of the synoptic Gospels is read, and they are examined in the subject matter and teaching of it. Then St. John is read, and another examination held, after which all satisfactory candidates are examined privately; and those finally accepted, after a little further instruction from the European missionary, are baptised. All the preliminary teaching is done by the native teachers, as also the examining in the Gospels.

We are hoping in a few weeks to take possession of our new church—a fine building, which, with a crush, could hold 800 or 900. We are hoping great things from the newly formed Australian C. M. Association, and hope before long we shall have some Australian brethren in Buganda.

Extensive building operations are now going on in connection with our work here. We have found it advisable to move from our first site to a more central position. Since we settled here at the beginning of last year, the chief of this province has moved his head-quarters, and now is close to us; he is the one I spoke of above as having been ordained a perpetual deacon. Besides the large church, mission premises are being put up. The Buganda houses are exceedingly neat. Of course they excel most in their old-fashioned, bee-hived shape houses, but now for several years the chiefs have been building houses with roof and walls. The day is soon coming, I hope, when they will build mud and sun-dried brick houses—in fact, they are already beginning—but still the reed and grass houses are exceedingly comfortable, clean, neat, and cool; stability is obtained by palm-tree stems sunk in pits four or five feet deep, at spaces six to nine feet broad. Some houses are as much as 30 feet high. The large church on Mengo is 40 feet, but for the very high ones forest trees have to be found. The upper ends of these posts have a notch cut upon them, and in these notches rest cross-beams covered with reeds and papyrus fibre (a beautiful white); a scaffolding is made, reaching to within about four to six feet of the roof. The roof is then built before the walls; reeds are broken over the roof-tree, and secured on each side, inside and out, by other reeds, covered with papyrus fibre laid on crosswise and bound on with twisted cord; and gradually the roof is completed to the outside walls. When thatched, which is the next process, no grass can be seen from the inside at all. The thatch is bound on in small handfuls, and at the top is secured outside by poles tied on lengthwise. When the thatching is finished, the thatch is neatly cut all round the house, so as to have a finished appearance. Then come the walls. First, reeds are put on crosswise at distances of eight or nine inches, and then grass is tied on to them, and other reeds hold it in its place; this is done on both sides of the poles of the wall. The final process is to sew on reeds lengthwise with bark. The appearance, when finished, can be exceedingly neat. The Baganda then, after levelling the floor, lay down a fine grass. We get our houses beaten, and do not have the grass; and during these days of jiggers frequently lay down cowdung, which kills the jiggers.

The national dress is the bark cloth, of which I enclose a little piece. It is the beaten-out bark of a kind of fig-tree; a large cloth, the size of the largest blankets, is worth 1s. 3d., and a fine one of a dark-red colour will fetch as much as 5s. The ribs on the cloth are made by the wooden mallet with which it is beaten In the houses it is used as curtains, and serves the purpose of blankets, and forms the clothing of nine-tenths of the people.

Bhang (or Indian hemp) smoking is a great hindrance in many parts of the country to the spread of the Gospel. In the adjoining country of Busoga there is scarcely anyone who does not smoke this pernicious drug; but in the country of *Bunyoro no one smokes it. Hence the Banyoro are much more ready to receive the Gospel, but the Basoga, although work has been carried on there for some three years, seem to make no progress. In Bunyoro there is a wide open door. Why should not Australia take up Bunyoro as her portion of this country? In Buganda the habit of bhang-smoking is mainly confined to the elephant hunters, and many of the chiefs have not courage to oppose it for this reason, as their hunters would leave them. This leads me to speak of the feudal system, which is perfectly exhibited in Buganda, just as, I suppose, it must have been seen in the old Britain. Hired labour is almost, and till lately totally, unknown. A man who attaches himself to any chief has a garden and building site given him, in return for which he can be called upon to work for his chief—bring him food, beer, &c. If he thinks he is worked too hard, or does not get a sufficient return, he leaves. Just tying up his belongings and shutting his house door, he is off to some other locality to

* Usually shown on maps as Unyoro.

try his luck with another chief. It is a most evil system, and leads to great idleness, and tends to hold back the prosperity of the country. Buganda has been so decimated by wars and pestilence, and by the old slave-trading, that whole tracts once cultivated are now gone back to desolation; chiefs who were once wealthy and powerful are now scarcely more than peasants. It remains to be seen if the British Protectorate, by keeping peace, has come soon enough to help the people back to life and prosperity. I trust so.

I must bring this to a close, with many apologies for its feebleness and disconnectedness. If it is thought worth reading, it may excite some little interest in God's work here.

7.—NATURAL FEATURES OF ISRAELITE BAY.

By J. P. BROOKE.

Balbinia, 25th July, 1894.

Baron Sir Ferd. von Mueller.

Dear Sir,—At Israelite Bay you can see a point where three formations meet, which I term the "Old," the "New," and the "Recent." I have, through Miss Brooke, your assurance that this spot has special interest to the botanist, and I have my own conviction that it must have an equal interest to the geologist, the meteorologist, and perhaps the geographer. Pardon me for mentioning meteorology first. The feature I take is what I term the *rainbelt*, which commences approximately on a ridge about 30 miles west of Esperance Bay. At the foot of this ridge, going eastward, are two lakes teeming at times with wild fowl. On the southern bank of one will be noticed the western limit of the *Zamia Dyeri*, peculiar to this district. These lakes are fed by the Daylup and other creeks, and beyond them is a vast forest of *yawl*, or "paper-bark tea-tree." Surrounding an old homestead of Messrs. Dempster Bros., on the south-western side of the *yawls* towards the coast hills, is a clump of stunted *jarrah*, with the undergrowth characteristic of this species of timber. This is the eastern limit of the *jarrah*. About 12 miles before reaching Esperance Bay the rainfall reaches its maximum, and just off the same bay begins the Recherche Archipelago, the scattered islands of which, while giving a charm and beauty to the scene which I shall not attempt to describe, are a source of danger and anxiety to our navigators. The heavy rainfall continues till Cape Arid hills are passed, when its volume again decreases; about here is the Rubicon Creek, which is remarkable as being the last watercourse met with for several hundreds of miles. Imagine, if you can, travelling on the shores of the vast Southern Ocean for many weeks, and far on into South Australia, without seeing a single stream running into it. On the eastern banks of the Rubicon are growing the last specimens of the "cabbage" or "Christmas tree." A few miles further we pass the hill of Cape Paisley, and here the rainbelt may be said to terminate, for although Point Malcolm and even Israelite Bay receive more rain than any point beyond, yet it is so uncertain and limited that they cannot be included in the belt. The rainbelt runs therefore east and west in full strength about 100 miles, with a lighter fringe of 18 miles in length on the west, and a corresponding fringe of about 12 miles on the eastern border; unhappily its extreme width is under 10 miles, and is mostly far short of that distance. The character of the country is locally termed "*Quowcken*" or "Sandplain." The meaning attached to this word "*Quowcken*" by the aboriginal natives is simply an open plain without timber, and would equally apply to clear, grassy plains; whereas a European only applies it to these extensive scrubby plains, thus giving it a special significance. A singular feature throughout the *quowckens* of the rainbelt are the numbers of *yate* and *yawl* swamps. Occasionally a swamp will be found where only one of these trees is represented, but usually both are more or less mixed. Generally these swamps have grass in them, affording camps for travellers and shepherds. The soil of the *quowckens* at first sight appears to be sand, but closer inspection will show it to be a poor sandy loam, though there are extensive tracts of pure sand in many places. After heavy rains the whole country is covered with water for miles and miles, the water lying on the sides and tops of the hills as well as on the flats, because the tussocky nature of the scrub, rushes, and coarse grass offers so much more resistance than finer grasses that the water is impounded for the time. I think many of the flats and swamps should grow flax, and, if the heat be sufficient, rice. At any rate in some future day these same *quowckens* will have a far greater value than at present, for they now possess a magnificent climate, a grand rainfall, and a clay bottom; they only require cleaning, sweetening, and manuring to become a most fertile territory. A peculiarity of the gullies and watercourses here, by courtesy called rivers and creeks, are the noble banks they have. The *quowckens*, though undulating, present a very level appearance, and a traveller will without notice suddenly find himself on the summit of a hill, while 100 feet or more below him runs a beautiful grassy valley, and opposite him another steep hill, the top of which is again the *quowcken;* in the bottom of the valley is the gutter in which, for eight or nine months of the year, a tiny stream of generally salt water is trickling; but in most of such creeks strong soaks exist, so that fresh water can be obtained by sinking two feet or three feet often quite close to the salt water of the creek. About once in twenty years an exceptional season occurs, and then these streamlets become for a few days rushing torrents, tearing out trees, rocks, and everything opposing their course; sweeping away sandbars and hummocks which have formed at their mouths, and so for a few days run into the sea; but as their entire course rarely exceeds five miles, it is only a flash, and then the sand fills in again, and the torrent becomes a trickling gutter. The same grassy valleys of these creeks have splendid soil, and would grow luxuriant crops of all kinds. Ten thousand pities they are not more extensive. East from Point Malcolm, and equidistant from it and Israelite Bay, a rocky hill appears to rear itself right out of the ocean; this is the hill on Christmas Island. This island, with the Caterpillar Reef, Hassel's Rock (an islet off Israelite), and a few other rocks and isles are the eastern termination of Recherche Archipelago, and 30 miles south of Point Malcolm the islets attain their southern limit in "Pollock's Reef," the dread of mariners. So these beautiful and interesting islands are dotted all over the ocean for about 150 miles in length by 50 miles in breadth. Many are extremely fertile; some abound with *Tammur*, some have rabbits, some are the haunt of the wild goose, and nearly all are occupied with penguin, mutton birds, and wild ducks. Here, too, is the home of the seal, both hair and fur; and glad am I that the Government have afforded them protection in their Game Bill, as the wholesale slaughterings lately conducted, at a time when the poor little cubs could not exist alone, would only end in their extinction.

This archipelago is capable of supporting a large population. When West Australia affords a market, I shall expect to find here a hardy people combining fishing and market-gardening. Where on the face of the earth could invalided Indians or Australians find a more perfect sanatorium with a climate which shows neither extreme?

I proceed to another natural feature. Hitherto the coastline has been very broken and irregular, affording numerous bays and harbours, several of which, as Esperance Bay, the Duc D'Orleans' Bay, &c., offer safety and accommodation for a fleet; the general run of the line has been almost east and west, the northing made being almost imperceptible. On passing Point Malcolm, however, all is altered; a most decided trend to the north is noticed; a low, sweeping sandy beach is seen quite dazzling in the bright sunlight, and you are aware you are at the western end of the Great Australian Bight. Away in the distance you can see some higher sandhills, and they, the sea, and sky get so mixed you cannot say where one ceases and the other begins; beyond is Israelite Bay. Here, it will be found, the sandhills overlie a large granite rock protecting them on the seaward side, and named Point Dempster. This sand-patch, though by no means the last of the sand-drifts, is the last of them composed of white sand. A low sandy curved beach, at the end of which, opposite to Point Dempster, and about three miles from it, is a small granite rock named Point Lorenzen, an island in the high tides and almost connected with Point Dempster by a reef. Such is Israelite Bay. Beyond Point Lorenzen for two or three miles the granite crops up again on the beach, and this is its eastern limit on West Australian shores, and it is abreast of the last of the islands; and then for miles ahead you see the white sandy beach, and the long lines of breakers slowly rolling in on it. Arrived there it is still white sandy beach, almost a right line, for miles at a stretch; you look back and it is the same, and ever in the distance has a smoky appearance from the mist off the breakers. This is the Seventy-mile Beach. I may as well state here that there is nothing cramped or confined in any of the features of this country; all its proportions are on an ample, if not colossal, scale. Thirty miles from Israelite Bay is the Wattle Camp Sandpatch. The reason I mention it is that an observer will notice the difference between this and any other hitherto passed, the sand being so fine and possessing a yellow tint.

From these sandhills, looking north-east along the now slowly curving beach, will be seen in the distance what look like five or six gigantic sugarloaves or icebergs on top of the sea. This is the Point Culver Sandpatch. It is 25 miles in length. The highest points must attain 150 to 200 feet, and it is said to greatly resemble a vast snowdrift. The wind blows the fine sand into a crest on the summit of the hills with an edge as sharp and clear cut as a knife, and the eye follows these undulating lines for miles until lost in sheer distance. These sand-drifts, but particularly this one, have a calm majestic beauty all their own. If you are on the inland side, the deep blue of the ocean and the paler blue of the sky form a fitting and pleasing background to the pure statuesque hills. If the traveller is on the beach, they are thrown up in strong relief against the dark line of the cliffs, and at sunrise or sunset the exquisite glory and softness of tint and colouring is a dream, a thing defying reproduction; and one could watch for hours the strange play of light and shade. I was travelling here on one occasion when, owing to refraction, Mount Rugged and Mount Russell could be plainly seen from beneath the cliffs. On ordinary occasions Mount Dean—the nearest of the hills—alone is visible from the top of the cliffs, and I could see the whole coastline right down to Point Malcolm—a distance of nearly 90 miles—with Christmas and New Year Islands, and the adjacent rocks and isles, quite distinctly. I shall never forget the strange fascinating beauty of that scene. The coastline continues its north-east course, past Point Dover (near which Eyre's overseer met his untimely fate) and Eucla to a point near Fowler's Bay, named the Head of the Bight, beyond which it turns to the southward, forming the eastern side of the Bight.

I must ask you now to return to Cape Paisley. Right at the back, or inland side of the hill, the *quowcken* drops suddenly, forming a long, low hill or range, not unlike one bank of some of the creeks already mentioned, only the other bank is wanting, and there is no creek below. The range runs nearly north four or five miles, and then trends to the east when it gradually gets higher and steeper, and is crowned first with low stunted mallee, but the farther you proceed the higher and denser the mallee becomes, while limestone appears cropping upon the surface. At short intervals, throughout, long gulches are met, in one of which, abreast of Cape Paisley, the Zamia finds its eastern limit. Suddenly the range turns to the north again. From this point runs a line to Point Malcolm, and you have the eastern limit of the "Blackboys."* In the mallee on the side and summit of the range will be found a good deal of "Marlock poison." Following the range on its northerly course for three or four miles the inland road from Israelite is crossed, when suddenly the range nearly doubles its height and becomes almost perpendicular on the face. Here then commence "The Cliffs." They are charted as Hampton Range, but no one ever dreams of calling them anything else than "The Cliffs"; and here, as far as soil and vegetation is concerned, you must say farewell to West Australia.

We have already left the creeks and swamps, the *jarrah*, the blackboys, the palms, the cabbage-tree, and now you will find no more "Marlock poison"† or other poison plants, except *candyup* grass;‡ no more *quowcken*, no more clay or ironstone. Soon, too, we shall see the last of the *yates*, *yawls*, and granite, proving to the great satisfaction of my mind the strong affinity there is between botany and geology—that is to say, given a certain geological formation and there you will find a certain botanical collection.

It is at this point where the three formations before alluded to meet each other, for on the road before mentioned you find the grey and yellow coloured clay, the coarse-grained granite so full of

* *Xanthorrhœa.* † *Gastrolobium.* ‡ *Agrostocrinum.*

mica and felspar, ironstone, gravel, and earthy limestone, characteristic of what I term the "old formation," while close at hand rears up the newer one of hard flinty limestone alone, and on the low-lying country between the foot of the cliffs and Israelite Bay, and running right up to Point Culver, is the quite recent formation consisting of sandhills, but little differing from driftsand, samphire flats, and salt lakes, formerly probably banks of seaweed and marshes on the shore, and a thin layer of sandstone which is apparently only forming; also, shells are found lying intact on the surface of the dry salt lakes identical with those thrown upon the beach to-day. That volcanic action has been at work here in the past can hardly be doubted; we have had tidal waves and several earth tremors since settlers first ventured here, showing that these forces are not yet extinguished. Are they still working? From indications I have watched on the beach I am inclined to think they are; that slowly and imperceptibly the earth is gradually rising above the water. There are channels in the rock on Point Dempster, where the waves wash to and fro, which are filled with waterworn boulders and pebbles; but in these same channels, far above the action of the present highest tides, there are still waterworn boulders and pebbles. Farther eastward, on the Seventy-mile Beach, the land has made nearly half-a-mile in width since I first saw it eighteen years ago; and at one place there, below some low sandhills, four or five distinct lines of steps or terraces can be seen, as if the deposits of sand and seaweed left by the tides were regularly receding. Another problem agitating my mind is, Was the granite formation forced up through the limestone, lifting the limestone (the sea bottom) up with it? Or was the bed of the ocean raised up till it overflowed the adjacent granite belt? To the unlearned bushman the indications apply either way. The cliffs run almost parallel with the coastline, but gradually approaching it, till at Point Culver the tides wash their base. To say there are no gullies or evidence of water action would be wrong; but the contrast to the long, winding gulches of the older formation is very marked. These short precipitous indentures can hardly be called gullies. I regret I cannot corroborate a report I have read by the Government Geologist, Mr. Woodward, wherein it is stated that, owing to the porous nature of the limestone, water is found oozing out on the face of the cliffs like springs or soaks; he has, unhappily, been misinformed. Such a desirable state of things would transform everything, the hardships and fortunes of the settlers included. Nevertheless, they are not entirely destitute of water, for not only on the face of the cliffs but all through the limestone there are rockholes, the *karo-gabby* of the natives, the largest of which contain from 100 to 400 gallons of water; but though generally sufficient for aboriginal needs, they are quite inadequate for Europeans and their stock. Are these holes formed by the action of water revolving a boulder in the softer rock? There are also "blowholes," deep round shafts, generally perpendicular and about two feet in diameter, of variable depth—some as deep as 150 feet; others are in a slanting direction, and perhaps run for miles. Out of them the wind rushes with a roaring sound, with sufficient force to carry a felt hat with it; in others, again, the air is rushing inwards. There are depressions in places like landslips, and there are caves, some of them of immense size, some of which contain a white substance like flour; it is simply carbonate of lime, and if we had a wetter climate no doubt stalactites and stalagmites would be formed. Somewhere I have read a description of the chalk downs of Kent and Sussex, in England, which is so applicable to these cliffs that I quote a portion—"These downs are covered with a sweet, short herbage, forming excellent sheep pasture, generally bare of trees, and singularly dry, even in the valleys, which for miles wind and receive complicated branches, all descending in a regular slope, yet are left entirely dry, and, what is more singular, contain no channel and but little other circumstantial proof of the action of water, by which they were certainly excavated." With a few modifications this is an exact description of these cliffs. For some miles from the face of the cliffs they are clothed with a white-barked, thick-leaved mallee, sufficiently thin and open to drive a team through without cutting a stick, and in many of the valleys—beyond Point Culver particularly—there are patches or "paddocks" of grass of excellent quality; and everywhere among the mallee, throughout their course, the bushes growing are good top-feed for sheep, and are, I am told, identical with those in South Australia; and there is everywhere a short, dark, wiry grass called "black grass," which is edible for stock when springing up green after a fire. The one thing lacking is water; otherwise here is room for many thousands of sheep. Eastward, the Nullabor Plains come in almost to the edge of the cliffs, and afford grand pasturage for sheep, but nothing has been done yet with them; owing to the water difficulty. The last *yawl* trees to be met with are beneath the cliffs at Point Culver; the last granite I know of is three or four miles eastward of Wattle Camp. The termination of the *quowcken* is about 15 miles north of Israelite, though there are some patches on top of the cliffs resembling them, but they differ in herbage, and they have no clay.

There are *yate* flats scattered about on top of the cliffs approaching a line running north from Israelite. East of that line I have met none, so I believe it to be their limit; but from this line to Point Culver I am not sufficiently acquainted with the country to be positive. From Point Culver the cliffs run overhanging the sea for more than 100 miles; they then recede as much as 20 miles or more from the present coastline, but meet it again just beyond Eucla, beyond which they gradually lose their hitherto almost uniform height of 300 feet, till finally they are lost near the head of the Bight; beyond Eucla I have not travelled, so I can only speak from report. So from their commencement near Israelite Bay, to where they meet the sea beyond Eucla, they extend in an unbroken uniform height for 450 miles; and now over this route, marching to the strains of "Killaloo," and saturated in dreams of future golden wealth, is daily pouring, from all corners of Australasia, a suffering, starving crowd of men, a very few of whom may partially realise their golden dreams, but the majority, poor fellows, will meet with only greater suffering and hardships; and still they come.

From Esperance Bay to Cape Paisley, and as far north as I have ventured—50 or 60 miles north of Lake Lefroy—the country is studded with low rounded granite hills and rocks corresponding to the is lesand reefs of the archipelago; from the north line from Israelite

Bay they extend westward almost to York and Toodyay, but east of the north line there is but one rock, and that close to the line; the remainder is universally limestone. West of the line is a strip of country 20 to 25 miles in width where the two formations seem to be mixed. So, then, if you have been able to follow me, we find my *Recent Formation* extending from Point Malcolm to Point Culver, and between the sea and the cliffs, and again from where the cliffs recede from the sea (about 20 miles west of Eyre's Patch) right down to Eucla, bounded again by the sea and cliffs. My *New Formation* extends eastward from a line running north from Israelite, how far I cannot say, but far into South Australia; and I do not know how far north, but I am acquainted with it for 150 miles. My *Old Formation* embraces all the country west from the line, and you will not forget the strip where the *Old* and the *New* appear mixed. Speaking in a very general sense, the flora of the *New* is common to South Australia and the flora of the *Old* to West Australia, while the *Recent* partakes of both, but that flora predominating to which it is nearest, that is, from Eyre to Eucla it resembles the South Australian flora most, and from Point Culver to Israelite Bay it is closely allied to the West Australian flora. If you could travel overland from Israelite Bay to Albany as I have done in or about the month of August, I believe you would fairly revel in the floral wealth exhibited. I should like to tell you a little more about my friends, Mount Rugged, Mount Russell, and Mount Dean, but time presses.

By far the most conspicuous object from sea or land is Mount Rugged, or "Barning-gunyah" with the inland natives, and "Carta-Currup" with the coastal tribe; it is charted most frequently Mount *Ragged*, which name is far too suggestive to our settlers of the tattered appearance of the natives, so it is unanimously styled Mount Rugged here. Within a circle, having a diameter of 100 miles, and far out at sea, he rears his stately crest, towering, like the ancient Israelitish monarch, head and shoulders above his fellows.

This hill is about three miles in length, running north-east and south-west; it is a few feet short of 2,000 above sea level, but loses greatly in its situation, as about two miles from its base the ground rapidly falls, so that the hill rises out of a deep valley, like a dry moat round some old castle, or as if, when all was new and soft, the weight had pressed the foundations down. The summit is so sharp that one can sit astride as on a horse; both sides are very steep, but especially the north-west, which drops away sheer down. About midway down the south-east side is a terrace, with but a slight gradient, after which the downward slope is resumed, but not at such a steep incline as in the first. There are several gorges on this side, as well as on both ends of the hill, in all of which clear, cool, fresh water is found slowly trickling; and in rocky hollows sufficient can be obtained generally to water a few horses. Price's Spring—after Mr. C. D. Price, who found and opened it out—is the chief of these, and at first was considered to be a spring, but has failed several times since to yield any water. At first one takes the rock composing these hills to be granite, but on closer inspection it more nearly resembles quartz; and from its laminated character, I think it must be mica schist—at any rate, it is neither quartz nor granite. The sides of the hill are all covered with hard, thorny scrubs, and loose, flat stones, rendering walking up or down (but especially down) both difficult and dangerous. Towards the base a great deal of ironstone shingle and gravel and nodules of quartz are mixed with the sand and loose stones. Here flourish four different kinds of poison shrub, also a dwarf eucalypt, with enormous leaves and a gorgeous red flower. In the valley surrounding the hill are several *yate* swamps, or flats—as they rarely contain water—in which grass, as usual, is found. Below Price's Spring there is a nice patch of grass, with *Casuarina*, peaches, wattles, and, in the gorge, willows growing; otherwise Mount Rugged is surrounded by *quowcken*, on which grows Mount Rugged poison, somewhat resembling a heartleaf poison shrub (*Gastrolobium bilobum*). It also occurs on the Phillips River. Separated by a valley from Mount Rugged, and slightly more inclined to the east, is Mount Russell. I do not know its height, but estimate it to be about 1,500 feet. On the south-east side is water, and below a patch of she-oaks, grass, &c. The Mount Dean hills run north-east also, commencing nearly six miles south of the eastern termination of Mount Russell, and are about ten miles long. The chief hill (Mount Dean) is about as high as Mount Russell, with a corresponding patch of grass, she-oaks, water, &c., ever on the south-east side. There are four other conical points of lesser height on this range. The foregoing description of Mount Rugged serves equally for the other hills, so I need not repeat it. When seen from a ship's deck, they appear as one range; but they run as I have described.

Mount Rugged is situated 25 miles west-north-west from Israelite Bay, and about the same distance from Balbinia. Bearing about ten degrees west of south, the highest hills of Mount Russell bear north-west from Israelite, and the highest point of Mount Dean about north-west by north. A south line from Balbinia—which is in lat. 33° 4′ 41″ S.—runs about equidistant from Mount Russell and Mount Dean. The highest peak of Mount Rugged, above Price's Spring—the north-east knob is the same height, within a foot or two—marks an angle in the division line between the Eucla and the Central districts, the boundary line running hence north and west, so that from some caprice a 20,000-acre block costs the unhappy settler twice as much on one side of these lines as on the other, while the land itself is equally poverty-stricken. To the wearied and perspiring pioneer, who has arduously toiled on hands and feet to attain the summit of Mount Rugged—anticipating a view of broad, rolling plains of bright, waving, yellow grass, studded with clumps and ridges of the brilliant, dark-green (so-called) S.A. sandalwood, or the bluish white of salt-bush plains—the endless panorama which meets his gaze is a cruel disappointment, so dreary, cheerless, and solitary is the dark funereal hue of the immense undulating sea of *Eucalyptus* and *Melaleuca*, melting away in the distance to a smoky blue on the one hand, and the desolate grey of the vast *quowcken*, bounded by the ocean line, on the other; and the survey produces a feeling of horror and loathing. Yet, when impartially viewed, the scene is neither devoid of interest nor of beauty. Away there on the coastline are the white hills of the Israelite Sandpatch, showing clearly against the deep blue of the sea beyond and the snowy white of the breakers as they dash against the rocks and isles of the archipelago, slowly rising and subsiding, as plainly at this distance as if it were but a stone's throw. Yonder pale-blue hills are the Cape Arid Range, with Mount Baring, Gingotup, Mount Mica, and the Pups closer in. Still further to the south-west are the Twin Peaks and the hill at the Bay of Duc D'Orleans. Quite south-west, like a faint blue cloud on the horizon, is the Frenchman's Peak in Cape Le Grand. That hill to the westward is Mount Ney, and beyond in the dim distance is Mount Ridley. There, beyond Pine Hill, is the large salt lake with its numerous banks and islands looming white and glaring. That hill to the north-west is Breminna, the western extremity of the rocky range which runs past Bundaminna, Walbye-roonia, Wadramilla, Gillarginnia, Mingamo, Booey-booer-inia, Chooka-la-oonia, Daralinia, right round to the northward till it runs out at Bowinia, nearly at the back of Balbinia.

I am, dear Sir, faithfully yours,

J. P. BROOKE.

P.S.—*Re* meteorology, we had here a brilliant Aurora Australis in March, a snowstorm lasting two hours on 30th May, and another aurora on 20th instant. Two aboriginal young men said they had seen snow before when they were children, that it came in the night, and the ground was white with it in the morning. On this occasion it melted as soon as it reached the ground. Some older natives had never seen it before, and they have no name for it, but say it is water.

J. P. B.

8.—ROTUMA.

By the Rev. W. ALLEN.

Rotuma is said to be in 12° 30′ south latitude, and 177° 10′ east longitude, and visible at a distance of 35 miles. It lies east of Brisbane about 1,600 miles, and is said to have been discovered by Pandora in 1793.

Configuration.—A glance at the accompanying map shows the peculiar configuration of the island. Roughly speaking, I should say the island is about ten miles long and four miles broad. The narrow neck of land shown on the map is only about 100 yards across. It is composed of sand, and is flat, so that a boat can easily be taken across from one side to the other. On this isthmus the natives have sunk wells for water eight and ten feet deep, through sand only. Rotuma, I believe, was once two islands more than a mile apart. By the daily flowing of the tide from east to west, and, perhaps, more especially by the moving of vast quantities of sand during hurricane seasons lasting for long periods of time, such an accumulation of sand has been caused at this place as to fill up the channel between these two islands.

No River or Lake.—Although Rotuma has an average rainfall of about 150 inches each year, yet there is not a single river, lake, creek, or stream of water on the island. All the rain seems to be absorbed by the porous nature of the country. The inhabitants get their supply of water from wells which they have sunk; but all the water found in these wells is brackish, and appears to be the ocean water filtered rather than accumulations of rain-water. In consequence of the brackish nature of the water in the wells, it is not used extensively for drinking purposes, the natives preferring the rain-water caught from the thatched roofs of their houses, or the water of the cocoanut.

Volcanic Origin.—Many of the islands to the north of Rotuma lying near the equator are of coral formation, and only elevated a few feet above sea-level; but Rotuma, on the contrary, is mountainous, having a ridge of hills running nearly through the island about 600 feet high. It is evident that Rotuma is of volcanic origin, there being two extinct volcanoes—one in the centre of the island, and the other at the extreme west end. Several persons have been down the latter, and have travelled its subterraneous passages far from the light of day. In different places there can be clearly traced the broad belt of lava, which flowed not only right down to the water's edge but out to low-water mark. Volcanic conglomerate, tufaceous stones, porous and compact basalts are found of every texture, of many colours, and in various stages of decomposition.

Coral Reefs.—Rotuma, like the great majority of islands in the Pacific, has its coral reefs. The island is enclosed by a coral reef, with a break here and there. At places the reef extends one or two miles from the shore, at others scarcely allowing room for the passage of a boat within it, and then disappearing altogether for a short distance. Inside the reef the water is shallow, not sufficiently deep to allow a boat to proceed at low water. At the islands west of Rotuma there is a large coral reef, not only extending from island to island, but far beyond. Upon whatever theory we may account for the construction of these immense coral reefs, there are, I think, unequivocal signs that they are undergoing dissolution. I am acquainted with reefs to the extent of hundreds of miles in Rotuma and Fiji, and I have noticed innumerable cracks and fissures, and even caves scooped out of the coral wall by the incessant action of the water. There are signs innumerable of decay and spoliation, but I have seen no indication of power to repair the damage done. When the reefs lift their heads to the water-level, they not only seem to have no further power of growth, but from that time are a prey to the ravages of the elements. It is a theory that has been advocated by some that there are no passages in a coral reef where there is no fresh running water, and that opposite every opening in the reef there must of necessity be a river or creek. It is true, I believe, that opposite a river you will generally find a passage in the reef, but at Rotuma we find several passages in the reef, but not a single river or creek on the island.

No Harbours.—In Rotuma there is no harbour for shipping, but simply two open roadsteads. A change of wind may necessitate all shipping proceeding at once to sea. If caught in a hurricane there is no hope of safety for vessels of the class that trade with the islands. For these reasons sea captains do not care to visit the island, especially for the first three months of the year.

Garden of the Pacific.—Rotuma has been called the "Garden of the Pacific," because of its beauty and fertility. Whichever way you approach it from the sea, no barren rock meets the eye—it is evergreen. From the highest peak down to the water's edge there are to be seen tens of thousands of cocoanut palms, waving their plume-like heads in the breeze. Nature is clothed in her magnificent multiplication of colours; the great forest trees are festooned with vines of every shade of gold, green, and crimson. There sits fair Rotuma in gorgeous beauty, unknown outside the tropics as an emerald isle on a sapphire sea. The shallow water enclosed by the coral reef presents a great variety of green tints; beyond is the deep ocean blue, while the perennial verdure of the island and the glowing azure of the ofttimes cloudless sky present to the eye of the beholder such a blending of colour as the earth can scarcely duplicate.

Productions.—The fertility of the soil is very great; everything grows luxuriantly and quickly. The chief productions are cocoanuts, oranges, lemons, limes, taro, yams, kawai, bananas, sweet potato, sugar-cane, sago, bread-fruit, coffee, cocoa, mummy apple, arrowroot, and maize; and other esculents they find in the bush in the form of roots, berries, nuts, and fruit. Patches of tobacco are often seen. Kava (*Piper methisticum*) is very largely grown, a single root sometimes weighing more than 100 lbs.

The Fauna.—The fauna of the island is somewhat disappointing. With the exception of wild pigeons and sea birds, there are few other species at present. Report says that they were plentiful, but during a very severe hurricane that visited the islands some years ago they nearly all died. There are no wild animals, but a few non-venomous snakes. The sciences of entomology and conchology are full of interest.

Seven Tribes.—Rotuma, although of such limited dimensions, is divided into seven sections or tribes—namely, Noatau, Oinafa, Malaha, Itutea, Itumutu, Faguta, and Pepsei. Each tribe has its own chief. Formerly there was but little intercourse between these tribes, and often they were at war with each other.

Annexation.—In the year 1881, at the request of the Rotumans, the island was annexed to the colony of Fiji, and thus became part of the British Empire.

Adjacent Islands.—Lying in a line with the coral reef that surrounds Rotuma, there are four small islands; also, some four miles to the west there are three islands in a line. The most northerly of these, Uea, is inhabited at present by some thirty persons. The island is in the form of a sugarloaf, and, strange to say, possesses a never-failing stream of pure water. Because of its exposed position, the island can only be approached in the calmest of weather. Hoflua, another of these westerly islands, is uninhabited, but is remarkable owing to the fact that it is divided into two parts by a narrow strait of deep water just wide enough for a boat to pull through, while high overhead the rocks are connected, forming a huge archway.

II.—THE ROTUMANS.

The population of Rotuma at present is not much above 2,000. In complexion they are a light copper colour, more resembling the Samoan and Tongan than the Fijian, though not as big-boned as the Tongan. The oblique eye, flat, wide nose, straight, coarse, black hair seem to indicate that originally the Rotumans were of Asiatic origin, probably Malay; but their own tradition says that they came from Samoa.

Tradition.—Their story is that a Samoan named Raho was badly treated in Samoa. Having consulted his god, he determined to leave his home. His god having told him to collect two baskets of sand, he put them on board his canoe, together with a quantity of food; and taking his wife and six other men and women, they set sail. Having sailed and paddled their canoe for days towards the west, they grew weary; and their god told them to throw the sand overboard. Having done so, immediately there grew up from the ocean an island. This made the sea so rough that they were in great danger of being swamped. When the sea became sufficiently calm, they approached the island, and found on it a great number of vegetables growing. This they called Rotuma. Here they settled, and, because they could not agree long together, they separated, thus forming the seven tribes into which the people are divided.

Physical Development.—As a race they are equal to the white man in physical development, having well-developed muscles. They are shrewd and adventurous, ready to learn anything from the white man, and to engage in any occupation, provided they are sufficiently paid. The Rotumans are said to make splendid seamen. Before annexation the island was regularly visited by numbers of whaling ships that came for the purpose of getting supplies of native food, and repairing and repainting the ships. The natives went on board those whalers out of curiosity at first, but afterwards great numbers shipped as sailors. By this means they have cultivated a strong liking for a seafaring life, and now every ship that touches at Rotuma finds young men desirous of visiting the world beyond their island home. Not only are the Rotuman sailors found in various parts of the Pacific, but some have reached Australia, America, and England. Nearly 200 young Rotumans are said to be occupied as divers, &c., in connection with the Torres Straits pearl-fishery.

Sons Encouraged to go Abroad.—Instead of parents trying to keep their sons at home, as with us, they do their utmost to induce them to go abroad to see the white man's land, and learn his language. There is scarcely a young man on the island, that is physically strong, who has not spent some months away from his island home. Of course, many who go away never return. The consequence is that there is a great preponderance of females over males on the island, and the natural growth of population is not only checked but the number on the island is getting less year by year; and unless some change takes place, in a few years they will cease to exist as a people.

One of the first things that strikes a stranger visiting Rotuma is the number of its graveyards. Wherever you walk, along the beach or inland, you will come across innumerable graves. It is the custom for every man to build his house on an elevated foundation, varying from two feet to six feet high. In every town that is now occupied, there are to be found many of these empty foundations, which tell too plainly of the shrinkage of population. Formerly there were several large towns inland; but they have disappeared, the population having died or left for the towns on the beach. During the last fourteen years I reckon the population of Rotuma has decreased by about 300. Some of the old men there say that many of the towns have not now one-half the population they had when they were young men. Formerly there was such a numerous population, requiring so many houses and so much firewood, that no person was allowed to cut down a tree without planting another in its place. But no such precaution is necessary now.

His Characteristics.—The Rotuman in his home is prudent; he counts the cost, thinks before he acts, is cautious; he is courteous and inquisitive. These two traits of his character shine out conspicuously in his dealings with strangers. He is extremely hospitable, giving the best he has to offer, and sometimes giving food when he has to go without himself. He is logical in his way. Everything English he thinks is better than Rotuman. "Their axes are better than our stone axes, their muskets than our spears and clubs, their knives than our cockle-shell, their ships than our canoes; the English have a God, therefore the God of the English must be superior to ours." Thus the Rotuman reasons. He is industrious, especially when away from home and thrown upon his own resources. At home the land, being wonderfully fertile, yields him all that he requires without his exerting himself much. Abroad, he works on contentedly day after day. It is this trait of his character, combined with his skill, that makes the Rotuman such a favourite among sea captains. He is also honest—always pays his debts. We never lost anything during our residence in Rotuma. A gentleman who lived there for twelve or fourteen years, who had two trading stations and daily business transactions with the natives, told me that, although he was under the necessity of giving them credit very frequently, yet, during all those years, he had never lost a pound. This will appear the more remarkable when we remember that it has been the law of the land, since annexation, that no white man can sue a native for debt.

Probably never Cannibals.—Whether or not the Rotumans were ever cannibals is doubtful. They have no written records that date further back than thirty years. With one or two exceptions, all that were asked stated that they never heard of any cannibalism in Rotuma. Nor does their language seem to possess any word equivalent to the Fijian word *bokola*, which signified human flesh to be eaten. If ever they were cannibals it is certainly not within the memory of any living Rotuman.

Their Knowledge.—Until the arrival of the white man these islanders had no written language; but from their ancestors, without the aid of books, they have acquired a good knowledge of the botany and natural history of the country in which they live. They have named every herb, shrub, and tree, and have ascertained the peculiar properties of many. Every sort of insect, fish, bird, and shells has been named by them, and they know the habits of many. Nor is their knowledge confined to the island on which they live and the briny ocean around them, for they have given some attention to the starry sky, not only naming the sun and moon but also the principal groups of stars in their horizon.

Ownership of Land.—Every Rotuman is a land-owner. All know their respective land. They have no title deeds in their possession by which to hold their land, but they have unwritten titles, handed down by their ancestors, which all respect. They all know the boundaries of their own and their neighbour's land, hence the infrequency of land disputes. During my residence in Rotuma an old man returned from sea who had been absent from the island fifty years. He had almost forgotten his mother tongue. He remembered, however, where his land was and its boundaries, and so entered into peaceful possession, although very few on the island remembered him. When a man marries in Rotuma he takes his wife to live in his tribe, but not unfrequently he spends two or three months each year with her people cultivating her land. The children inherit their father's and mother's land, and are regarded as belonging to the two tribes.

Cultivator of the Soil.—Every Rotuman is a cultivator of the soil, and seems to venerate it It is a real pleasure to him to watch the growth of the things he has planted. At sunrise he will often be found in his garden at work. All his food supplies come from his garden. The soil is so prolific he has little difficulty in raising sufficient food for all his requirements. His chief work is to keep down the weeds which grow so rapidly and threaten to choke what he has planted.

Houses.—The Rotumans' houses are not built on the same model as the Fijians, the Samoans, or the Tongans. They have not the two long central posts that are so conspicuous in the houses of the Fijians, nor the wood protruding at the top. The two rows of posts with the cross-timbers support the whole of the Rotuman's roof. The roof is covered with the leaf of the sago palm. One of these put on nicely is said to last without rethatching for twelve or sixteen years. The ends of a Rotuman's house are not square like a Fijian's, but round like a Samoan's. The Rotuman, however, cannot open the sides of his house, as the Samoan does. All the Rotumans build their houses on foundations of stone and sand, varying from two to seven feet in height. The doorways are seldom more than four feet high, and often only three. At the present time some of the Rotumans are building stone houses by the aid of burnt coral. In these houses they have wooden doors and windows of European manufacture. The floors of their houses are covered with coarse mats made of the leaf of the cocoanut palm plaited. On these are laid finer mats which the natives call *epa*. In addition to these mats the Rotuman women make a very fine mat which is much valued throughout the Pacific. They are called *apei*, and they can readily get £3 or £4 for one of them.

Canoe-building.—Canoe-building used to take up a great deal of the men's time. They made large double canoes. These, with their rude stone axes, took many years to build—often eight or ten. No nails were used; everything was fastened together with sinnet. With these they were enabled to reach Tonga and other places. Some, doubtless, were lost at sea with all on board. According to tradition, many years ago the island was overcrowded, and it was considered necessary to build canoes and sail away in quest of other lands on which to settle the people. At the present time there are no double canoes on the island, but some small single ones used for fishing about the reefs.

War.—War was not infrequent even on this tiny island, and as one goes from place to place he will find many large stones that have been erected to mark places where warriors fell. They speak of a war, in the memory of the old people, at which 100 were killed.

They used to fight with spears and clubs, bows and arrows, white and black stones. They had also their war songs. For fifty years past they have had firearms, and every house has one or two guns which they prize very much but use very little. Each of the seven tribes has had its boundaries altered again and again as the result of war. The last war occurred about eighteen years ago, in which four of the tribes were engaged and several men killed. Heathenism then tried to exterminate Christianity, but failed

Copra, &c.—The men, women, and children are all more or less employed making copra, large quantities of which are exported. They generally husk the nut, crack it in two, cut out the flesh with a large knife, and expose it to the sun for three days, when it is thoroughly dried.

Schools.—All the boys and girls on the island can read, write, and have some knowledge of arithmetic and geography. They meet their teacher in the school-house three days a week, from six in the morning until nine. Parents that fail to send their children are liable to a fine. Teachers are supplied by the church, and not by the State. Every householder in each town gives something quarterly towards the teacher's support.

MANNERS AND CUSTOMS.

Men and Women.—All the people in Rotuma wear clothing of European manufacture. It consists of waist cloth and shirt for the men, and waist cloth, skirt, and pinafore for the women. The men sometimes succeed in picking up an old hat cast off by some white man. When any of the men return from sea they always wear home a European suit, including hat, collar, necktie, boots, and stockings. Within twenty-four hours these will have been put away, and the new arrival will appear in the ordinary dress of the country. Generally speaking, the men appear to be superior to the women. The men work their gardens alone, and when they reach home cook the food. The women never cook. They mind the children, fetch water from the wells, make their mats, sweep out their house, sit, smoke, talk, and sleep. Rotuma is a lazy woman's paradise.

Cooking.—Almost all the food is cooked in the native ovens. This is a circular pit in the ground, containing a number of small stones, in which they make a fire. When the fire has nearly exhausted itself, the food is placed on these hot stones and quickly covered with leaves and sand. This keeps in the heat and cooks the food. The Rotumans, unlike the Fijians, use no native pottery in their cooking. Latterly they are beginning to use kettles, saucepans, and crocks of European manufacture.

Tattooing.—The Rotumans tattooed their body from the waist to the knee. None of this part was exempt. The dye they made themselves from the bark of trees, using fish-bones for their needles. The process was an exceedingly painful one, some even dying through it. Only a little was done at a time, just as much as the person seemed able to bear. Tattooing only commenced when they were young men, and no one was considered to be a man and competent to marry until he had been tattooed. The women were not tattooed, excepting on their face and arms.

Long Hair.—In their heathen state the men, as well as the women, wore their hair long, and, unlike the Fijians, failed to keep it trimmed. It was a long tangled mass reaching nearly to their waist, and dyed with lime and the bark of a tree, which they call *fav.* This made their hair red. The women dyed their hair with cocoanut oil and the bark of *fav*, which made their hair black. The single girls had a little of their front hair cut short, and also a little of the hair on each side over the ears. These three spots were coloured with white lime. The rest of their hair was black. Single girls were easily known by this badge. At the present time they have ceased to dye their hair. The men all cut their hair short, and nearly all the women do the same.

Changing Children.—The Rotumans have the unnatural custom of giving away their children to their relatives and friends. This is not the exception, but the rule. There are very few homes in Rotuma where brothers and sisters are brought up together. They are generally scattered, living in different homes. The parents instead of bringing up their own children bring up the children of some of their friends. This destroys the natural love that should exist between brothers and sisters, parents and children. When asked why they give their own children away and take the children of their neighbours instead, they answer, "It is the custom of Rotuma to do so, and shows that we love our neighbours and our neighbours' children." The one who adopts a child would be called by the child its *makiga*, while the person who adopts would call her adopted child her *mapiga.* The children go occasionally to see their parents, and will belong to their parents' tribe and inherit their parents' land. They are only given to be reared among neighbours and friends.

Circumcision.—Circumcision is practised among the Rotumans, as among the Fijians and some other islanders of the Pacific. The rite is performed when the boys are from twelve to sixteen years of age. They have a feast in connection with the ceremony, and but little privacy is observed.

Births.—The women suffer very little in parturition. A wide difference exists between the customs of the Rotuman and Fijian women at this time. A Rotuman woman when she knows that she is pregnant ceases work and continues to rest until the child is born. As soon as it is born, she gets up and goes for a bath in the sea, and returning to her house eats freely, and almost immediately begins to visit her friends and resume her household duties. The Tongan women have similar customs; but the Fijian women, on the other hand, work right up to the day of their confinement, after which they are forbidden the free use of animal food and fish for some days. They always remain resting in their house for a month or more. When baby is born a series of feasts follow which keep the husband busy, but the great feast is prepared on the anniversary of his birthday. On that day he is weaned and given to a friend to rear up. He is given away just as he is beginning to understand somewhat his mother's love. The mother generally sheds tears at parting with her child, but submits to the custom of the land.

The naming of a child takes place very early, sometimes before it is born, but generally within the first three or four days of its existence. The child is often called after one of its grandfathers, uncles, or other relative, sometimes after a ship, or a country, or flower, or tree, or animal, or fish, or after some peculiarity that the child may have. Sometimes the names given are most filthy expressions which cannot be mentioned in the presence of women.

Ancient Marriage.—When a young man wants to possess a wife, he makes a feast called *koa ne mos*, and sends it to the girl's house. On the second day, the young man makes and takes another feast called *fakpo*. On the third day word is sent to the friends of the young couple inviting them to the marriage on the next day. The fourth day all the friends arrive with presents of food, mats, &c. The young couple would smear their bodies with oil, turmeric, and yellow colouring, and so would the guests. They feast together, and sing to each other, the women singing to the men, and the men to the women. This is kept up at intervals all through the day and night. During the day the young couple were put on to a platform and carried round the village on the shoulders of some of those present. If the married persons are poor they are generally dipped two or three times in the sea; if they are people of rank they are simply carried round the village square with rejoicing. After this, about a dozen of the male friends of the bridegroom form a square around the young couple, and another man with a light tomahawk strikes each a blow on the head causing the blood to flow; so the marriage is ratified with blood. This brings the marriage ceremony to an end. How different the ceremony to-day!

Deaths.—It is the custom when any person dies not to let the body rest on the ground until buried. If it is a child that dies they hold it in their arms until it is buried; if an adult, the women sit on the floor in two rows facing each other, and let the body rest on their outstretched legs. Towards evening they sometimes make the corpse sit in a chair with a canopy over its head When ready for burial it is wrapped up in native mats and placed in the grave in a sitting position, three or four feet deep; they then bring up a quantity of fresh sand, and make a mound three or four feet higher. In this manner they bury their dead tier upon tier until their cemeteries are large mounds of sand some 20 or 30 feet high.

The "Sau."—There are seven tribes on the island of Rotuma, and each tribe has its recognised chief. But, in addition to these chiefs of tribes, there was formerly over the whole of Rotuma a man elected to be *sau*, or sacred king. He was regarded as a kind of god, and received homage and presents from the people all over the island. He was not allowed to do any physical work, chiefly confined himself within his house, where he was waited on hand and foot, and feasted to his heart's content. The *saus* were generally elected for short periods of six or twelve months. The five principal tribes took it in turn to select the *sau*. They would go into a neighbouring tribe and select their *sau*, and bring him to their own tribe to live with them. But he was *sau* for the whole of Rotuma, and all would willingly pay tribute to him during his term. The resignation of one *sau* and the initiation of another were attended with gross heathen customs, lewd and immoral.

Devil Worship.—The Rotumans were devil worshippers, and had their priests (*apeoiitu*) and temples (*rimonu*). These priests were consulted by the people in times of sickness, war, &c. The people always took presents of food, pigs, or mats. After presenting their gifts they remained in the temple and watched the priest, who presently began to shake and tremble. He is then supposed to be under the influence of the devil. The visitors were filled with fear, and waited anxiously to hear what the devil had to say through the mouth of the priest. The priest generally said something to please the visitors, after which the priest and visitors drank *kava* together, and then separated.

Climate.—The climate of Rotuma is very sickly. No European can remain there long without contracting diseases hard to be shaken off. It is difficult to account for the sickly character of the island; but some attribute it to the absence of good water, to the drinking of so many cocoanuts, and the oozing of water from the land into the sea at low water. There are no mangrove swamps in Rotuma. Several diseases are peculiar to the island, but the scourge of the place is elephantiasis and terrible ulcerous sores, which not only eat the flesh but the bone. Large numbers of the natives—men and women—are suffering from elephantiasis, and some cases are pitiable in the extreme. It attacks the arms, legs, heart, and generative organs. The last form of the disease is the worst. Some white men have been attacked by elephantiasis, but by leaving immediately for a cold climate have recovered; others who have remained on the island have succumbed to the complaint.

Forecast.—What will be the future of Rotuma and the Rotumans? This is an interesting question. Rotuma being part of the British Empire will probably remain so; but being small, without ports, without mineral wealth, and lying adjacent to Fiji, it is unlikely to be of much importance to the Empire. If, however, it had not been annexed by Great Britain, it would in all probability have been annexed by France. What will be the future of the Rotuman race? Will they disappear, as so many other races have done? We very much fear so. From the great number of graveyards on the island, and also from the vast number of stone foundations on which houses were formerly built, it is very evident that Rotuma was once densely populated. The present population is probably not one-third of what it once was. From my own observation, during the ten years from 1881 to 1891, the population decreased 200. This shrinkage is still going on, and is likely to continue for the following reasons among others:—

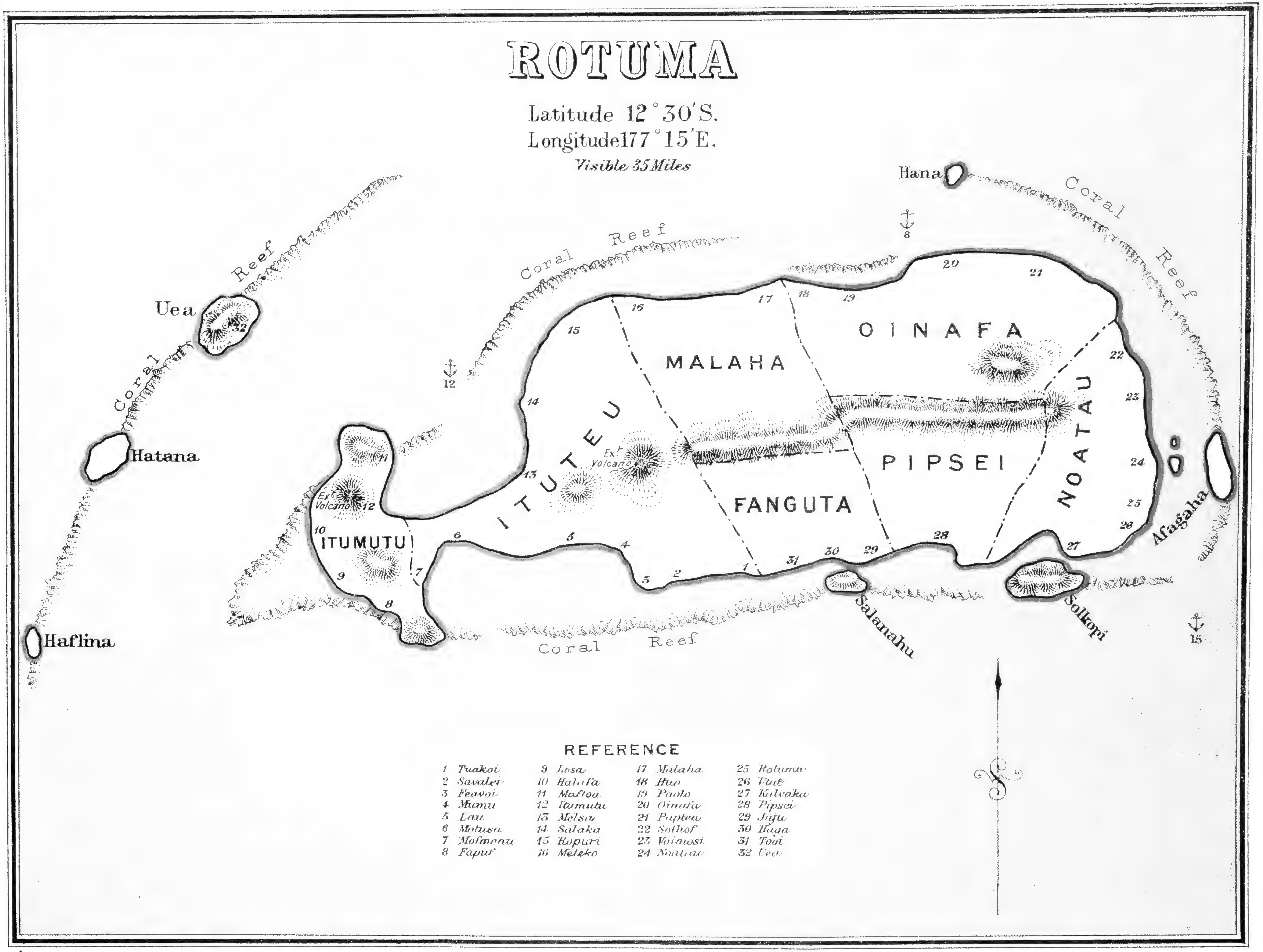
1. The majority of the young men leave the island.

2. The marriage relationship seems to be very weak. A large number of young married couples are living apart.

3. Deaths exceed births. Many use means to prevent child-bearing.

4. European diseases have been introduced which the natives do not understand; there being no resident doctor the people quickly succumb.

5. The natives wear clothing of European manufacture, but have no judgment as to how it should be worn. In the intense heat of the day they wear ample clothing; in the cool of the evening they are


ROTUMA
Latitude 12°30'S.
Longitude 177°15'E.
Visible 35 Miles
Hana
Coral Reef
Uea
Reef
Coral
Hatana
Haflina
OINAFA
MALAHA
ITUTEU
PIPSEI
NOATAU
FANGUTA
ITUMUTU
Ext. Volcano
Ext. Volcano
Salanahu
Solkopi
Afagaha
Coral Reef
REFERENCE
1 Tuakoi
2 Savalei
3 Feavoi
4 Mumu
5 Lau
6 Motusa
7 Mofmonu
8 Fapuf
9 Losa
10 Halafa
11 Maftoa
12 Itumutu
13 Melsa
14 Salaka
15 Kopuri
16 Meleko
17 Malaha
18 Huo
19 Paolo
20 Oinafa
21 Puptea
22 Solhof
23 Voimosi
24 Noatau
25 Rotumu
26 Utut
27 Kalvaka
28 Pipsei
29 Juju
30 Haga
31 Tooi
32 Uea

almost destitute. As a consequence they suffer largely from colds, chest complaints, &c. Their old method of daily anointing the body with cocoanut oil was more healthy than their present practice, I think.

Unless there is a decided improvement in the habits of the people, the Rotuman race will soon be extinct. If this comes to pass, the island, being so unhealthy, is not likely to be occupied by much white settlement, but may afford a comfortable abode for some of the overflowing population of India, China, or Japan.

9.—A VOYAGE TO KAGNABAK ISLAND, BISSAGOS ARCHIPELAGO.*

By MAX ASTRIE, M.G.S., Marseilles, late Vice-Consul for Turkey, Corresponding Member of the Geographical Society of Marseilles.

[Translated by A. J. Boyd, Hon. Sec., Sec. E.]

On the 8th June, 1894, I happened to be at Senegal at the conclusion of a tour of inspection on account of the "Société Flers-Exportation," when I received a letter from my dear friend and colleague, M. Paul Armand, General Secretary of the Royal Geographical Society of Marseilles, inviting me to contribute a paper to the Geographical Section of the Australasian Association for the Advancement of Science, whose annual meeting is to take place in January, 1895, at Brisbane, Queensland. Such a request was far from displeasing to me. Besides the friendship with which our eminent and beloved General Secretary has honoured me for so many years, I was not sorry to have the opportunity of exploring Kagnabak Island, so little known to geographers that nothing has as yet been given to the world concerning its topography and ethnology.

I accordingly at once made my preparations and quitted Dakar on the 11th June, 1894, on board a sloop named the "Savorgnan de Brazza."

The ship's company numbered seven, all told, including natives of Sénégal, a native interpreter from the Guinea coast, named Ounouma, I making the seventh.

I laid in a stock of provisions for two months, and ten bales of goods suitable to be given as presents to the various "kinglets" of the countries I was about to explore. I give the list, which I afterwards found pinned to my travelling note-book:—

	F. C.	F. C.
50 kilos leaf tobacco, at	2·00	100·00
3 kegs, each 100 litres brandy, at ...	60·00	180·00
50 dozen knives, at	6·00	300·00
10 barrels trade gunpowder, each 4 livre, at	3·00	30·00
200 coloured cottonade handkerchiefs, at	0·40	80·00
50 kilos Venetian beads, glassware, &c., at	2·00	100·00
Total		F. 790·00

On the 18th June, at 6 a.m., I arrived off the island of Galinha after a very fair passage void of accident or incident. This island, although situated in the centre of a maze of currents and counter-currents, badly defined on the charts, is nevertheless very easy of approach.

* Portuguese Guinea, N. W. Africa.

As the tide was against us, and more particularly as a strong southerly wind was blowing, I ordered the pilot to let go two anchors, and we lay off shore on the N.N.E. side of the island. Having secured the safety of the vessel, I had the boat lowered and went ashore, accompanied by three sailors and Ounouma, who acted in the double capacity of interpreter and servant. As for arms, I only carried a Winchester repeating rifle, the boat's crew being unarmed.

On landing we walked for half-an-hour over a beach of very fine, white sand, the reflection from which was very distressing to the eyes. We then discovered a track about three feet wide, which led us at once into a fine forest of palm-trees (not the African date palm), mango-trees, and silk-cotton trees (*Bombax*).

I do not know whether all travellers are susceptible of similar impressions, but, for myself, I confess that one of the principal charms of my explorations has lain in the unexpected and sudden discovery of these African forests with their foliage of brilliant verdure, their narrow pathways, and their gigantic and bizarre-looking lianas. As the traveller plunges into these vast domes of verdure, he is seized by that religious emotion which Chateaubriand speaks of in his admirable descriptions of the virgin forests of America.

We had marched thus for over two hours in Indian file, when suddenly we perceived two natives, nearly naked, who were sowing a ricefield. The instant they saw us, both uttered savage yells of terror, and incontinently took to their heels. But Ounouma, who had good legs, was after them like a shot, and in a short time had caught them and allayed their fears. A few tobacco leaves had the effect of fully pacifying them, and, thanks to the information they gave us, we succeeded before mid-day in reaching the principal village of the island.

The main object of my journey being the exploration of Kagnabak for the dual purpose of geographical research and commercial enterprise, it would serve no purpose to discourse at length on a description of Galinha, or of the mode of my reception by the King, Ondotto.* I therefore confine myself to the reproduction of the following notes taken from my memorandum-book and jotted down at convenient moments :—

The island of Galinha is situated to the south-west of Bolama, from which it is separated by a broad channel, through which pass all vessels navigating this archipelago. The inhabitants, to the number of about 350, belong exclusively to the Bijougoth race. They are an agricultural people, and cultivate rice, Arachis, bananas, and oranges, and devote themselves especially to the breeding of fowls. The name "Galinha," which in Creole Portuguese signifies "fowl" or "hen," was given to the island by one of Vasco de Gama's companions in remembrance of the quantities of fowls he found there. At present a singular disease is working havoc amongst these useful birds, which seems to threaten them with utter extinction.

* The title of king is given to each of the chiefs of the Bissagos Islands. It is not hereditary. On the death of a king, the Bijougoths (Bissagos) choose his successor from amongst the most eligible of the old men. All these "kinglets" are, as a rule, very poor. They go about clothed in rags, and wear as a distinctive badge of their royalty a tall hat. Nevertheless, they esteem themselves rich because they are contented with little.

At Galinha I found quantities of forest trees which would furnish admirable building material, and notably the guava, cailcedra (?), ronier (?), and silk cotton-tree, which is employed for building the boats called "pirogues." Besides, there is a tree peculiar to the island known by the common appellation of "acajou" or "cajou."

The natives have a detestable habit of burning every year a portion of their forests. This custom is due to superstition, but if such a deplorable superstition continue for another twenty years there will no longer be any forests to burn.

Up to this time no European has settled on the island. The natives make journeys themselves to the markets of Bolama and Bissao (a town of Senegambia, in the Rio Grande), where they obtain a ready sale for the products of their country.

The King, Ondotto, is a big, jolly fellow; old, but still youthful in manner and physical strength. He performs his royal functions in a very free-and-easy manner. I made him a present of ten litres of brandy and a kilo of tobacco. He was so delighted with this munificent present that during the whole of our explorations he would yield to none of his subjects the honour of carrying my rifle and my valise, my scientific instruments, such as the compass, the chronometer, the theodolite, &c.

I spent the day of the 19th at Galinha, and sailed again on the 20th, early in the morning, hoping to arrive at Kagnabak on the same day; but the tide compelled us to anchor at the Porcos Islands, which lie between Galinha and Kagnabak.

However, I profited by this *contretemps* to explore the three islets composing the group. The two smallest are simply deserts of small extent, and surrounded by scattered black-looking rocks, which serve to shelter vast quantities of fish. Amongst these the mullet abounds in shoals. On the principal island I found a great quantity of pigs* and goats. My interpreter told me that these animals had been taken there by the inhabitants of Kagnabak. These pigs and goats live in unrestricted freedom, and feed mainly on the nuts of the monkey cocoanut palm, which fall from the trees, and afford them a never-failing supply of most nutritious, oleaginous food. I need scarcely remark that the negroes of Kagnabak come over and take all the grunters they require for their own consumption.

In 1817, an Austrian brig, whose crew had been sent on shore to make a raid upon the porcine inhabitants of the woods, were attacked by the natives of Kagnabak, who massacred one white man, wounded five others, and recovered all their pigs.

I could not explain satisfactorily how it came about that this island remained uninhabited, notwithstanding the fact that its soil is particularly rich in humus. The vegetation here is simply magnificent, and the scenery enchanting, at least during the winter months. For my own part I retain the most pleasing recollections of it, although my sojourn of a few hours only was due to a cause beyond my own

* The name of "Porcos" is derived from the large number of pigs which roam about the main island.

control. Plenty of game, plenty of fish, ravishing woodlands, combined with a delicious climate tempered by the sea breezes—it is a perfect Robinson Crusoe's island, which would constitute happiness to anyone who is a lover of sea and solitude.

On the 20th we left Porcos at midnight, and in a few hours arrived at Kagnabak. I was still under the influence of a deep sleep superinduced by the fatigues of the preceding day and lulled by the gentle rolling of the sloop, when I was suddenly awakened by loud and prolonged savage yells.

I jumped for my Winchester, which I loaded mechanically, determined to repel what I took to be a premeditated, unlooked-for attack; but Ounouma seized me by the arm and said: "There is no danger. These two or three hundred blacks whom you see on the beach are some natives of Kagnabak, who, accompanied by their king, come to welcome you. They have had notice by means of a pirogue from Galinha, which went ahead of us, that a white man has arrived with the intention of establishing a factory on their island, and this welcome news has so delighted them that they have decided to come and meet you."

This explanation was most satisfactory to me, and a few minutes later I landed on the beach, escorted by my sailors and my interpreter, bearing tobacco, brandy, knives, and other articles usually given as presents. I at once advanced towards the king, whom I recognised by his tall hat. I halted at two paces' distance from him, saluted him courteously, and extended my hand, which he grasped energetically. I then turned to Ounouma and invited him to interpret the following speech:—"I am a white man from France, and I have come to visit your island, not only for the pleasure of making your acquaintance, but more particularly to satisfy myself if the resources of the country will admit of my establishing a factory amongst you. I thank you for coming to meet me, and in proof of my satisfaction permit me to offer you a demijohn of brandy, fifty hands of tobacco, and a knife."

As Ounouma translated my speech I noticed that the king's figure dilated, and when my interpreter had finished speaking a murmur of admiration arose amongst the crowd. The king made a sign, imposing silence, and then replied—"My name is Tayacouané, and I am king of all the island of Kagnabak. Since you have come here with words of peace and with presents, I welcome you. By-and-by you will explain to me the nature of the trade that you wish to enter upon in my island. Meanwhile, come with me that I may offer you the hospitality of my house." We at once set out, surrounded by a motley crowd of 300 negroes and negresses of all ages, who howled for joy and devoured me with their looks. In less than a quarter of an hour we had arrived at the principal village of the island, where King Tayacouané had set up his court.

I retain a vivid and agreeable recollection of my reception by His Majesty and his subjects. In order not to weary the reader of these notes, I pass rapidly in review the various minute vicissitudes of this trip which are foreign to geographical and commercial interests. Thus, during my stay, the king instituted two grand night *fêtes*, at which men and women got thoroughly well drunk on palm-wine. It was a disgraceful scene. To do me the greater honour there was a grand holocaust of fowls. On one occasion a *battue* on a large scale was organised for me. The game consisted of gazelles, and as a result fifteen of these graceful animals were captured. As a climax to all this profuse exhibition of regard and hospitality, Tayacouané pushed his anxiety to show his wish to make himself agreeable to me by insisting upon my acceptance of a young Bijougoth girl. As I did not wish to mortally offend his complaisant Majesty, I yielded, after much expostulation, by accepting the present; but, as may well be imagined, the verbal acceptance of the savoury dark-skinned beauty ended it.

Omitting details minute and picturesque, I will now give my impressions of the island and its resources, as I find these recorded day by day in my note-book. According to my calculation Kagnabak contains a population of about nineteen hundred all told They are all Bijougoths of a fine black colour and of perfect symmetry. The women are undoubtedly exceedingly ugly as a rule, and disgustingly filthy, notwithstanding their being almost nude.

This island, which, from a commercial point of view, is the most important one of the whole archipelago, is very advantageously situated between Boubak Island and the mainland. Up to very lately it acknowledged as its ruler Titiak, whose authority extended to all the other Bissagos Islands, but his successor, Tayacouané, the same potentate who gave me so cordial a welcome, inherited neither his prestige nor his influence. I have already remarked that the most humble chief of the smallest island was called king. Among the Bissagos royalty scarcely implies more than an exceedingly limited moral authority. There is no court, no civil list, no treasury. There are no duties or imposts. The peaceable monarchs of these miniature possessions confine themselves to superintending the ceremonies attendant on the rite of circumcision, to sacrificing to the gods, and occasionally to meting out justice. They are assisted in these scarcely onerous duties by the old men of the country, who give their services quite gratuitously. This primitive organisation is quite in keeping with the lazy habits of the natives, to whom any sort of work is an abomination, and who have no other object in life but to assure themselves of their daily bread, without troubling themselves about the morrow. In Kagnabak there are twenty-two villages ruled over by twenty-two chiefs, all dignified by the title of king. As I spent three weeks on this island, I was enabled to visit the whole of these villages, which resembled each other in a remarkable degree.

They are all situated at a distance of one kilometre from the beach. The reason for this appears to be that formerly the slave ships which scoured the Senegambian coast were in the habit of sending armed crews ashore. These marauders fell suddenly at night upon the villages on the seashore, and carried off their inhabitants. In order to render such raids impossible the kings ordered all villages to be built at a kilometre distance inland—that is to say, in the heart of the forests. Then they left dogs to watch at the deserted villages. When the slavers returned they were compelled, in order to reach the new villages, to march in Indian file a long distance inland. Meanwhile the Bissagos, warned by the barking of the dogs, placed themselves in ambush, and in the obscurity of the night were enabled to massacre the greater number of the slavers.

I now give the names and condition of the twenty-two villages of Kagnabak as I find them in my daily notes.

Nhoré.—This is the principal village, where King Tayacouané, the richest and most powerful of all the various island kinglets, resides. Tayacouané's authority extends even so far as Galinha. His possessions (*i.e.*, his personal property) consist of fifty head of cattle, forty goats, six houses, five wives, and fourteen children. I succeeded in buying here 100 bushels of palm-nuts in exchange for a little powder, brandy, and tobacco.

Anhoudiégué.—The Bissagos of this village differ from those of the former in being of a more ferocious disposition and of greater independence. It was these natives who, about twenty-five years ago, plundered a French coasting vessel and maltreated the crew. The Governor of Sénégal, having been immediately informed of the occurrence, sent out an expedition consisting of fifty soldiers of marines, who burned the village and killed several natives.

Ankaman.—Here are manufactured those famous assagais or Bissagos lances, the wounds caused by which are often mortal. These weapons, it is said, are dipped in some subtle poison, but I was unable to verify the fact.

Ambenou.—Skins being fairly plentiful at this village, I bought about fifty bullock-hides. These hides are of a singular fineness, of great softness, and are much sought after consequently by the leather merchants of North America, who employ them in the manufacture of fine boots worn by the elegants of Boston, New York, and Baltimore.

Anchorop.—On my arrival I found the inhabitants engaged in their fields sowing rice, and the only people left in the village were a few old men and children.

Amré.—This village would form an excellent base of operations for a trade in palm-nuts and bullock-hides. The people here exercise a truly Scotch hospitality, as I found at the house of a Bissagos named Nia-Counoun. This good man offered me and my escort milk, palm-wine, and oranges, all of which were especially welcome after a fatiguing day's march.

Angoumba.—On this island great care is exhibited in the cultivation of orange-trees. A native sold me a quantity of tortoise-shell worth 50 francs for a common knife. There are numbers of turtle in the neighbourhood of Kagnabak, but yet they are not sufficiently numerous to tempt anyone to try and make a lucrative business in the commodity.

Anhaoura.—There is nothing worthy of special mention here. The cultivation appears to be limited to oranges, lemons, and mangoes.

Ndénak.—Some trade might be opened up here in palm-nuts and hides.

Ankagno abounds in domestic fowls, banana groves, orangeries, and palms.

Bèné.—Here I observed a native blacksmith forging spear-heads. According to my calculation he produced ten heads after a day's hard labour for a reward of one or two halfpence.

Ambéna.—The chief of this village made me a present of some twenty "fetishes," rudely carved into what purported to be the figures of cows or elephants. They might have equally well passed for the figures of men and women. I was rather surprised, on my return to France, to find that these "fetishes" were most acceptable to my curio-collecting friends. The result, as may be anticipated, is that not one has been retained by me.

Enhoda.—This village would be an excellent trading station for establishing a depôt for the purchase and reception of palm-nuts and palm-oil.

Ankatil, *Ankaguil*, and *Ankenché.*—In these three villages nothing is to be got in the way of trade, as there is scarcely any product other than oranges and bananas.

Menek.—A considerable trade could be done here in "paddy" (rice before the husk is removed). The rice is very white and of superior quality. I bought fifty bushels for about ten kilos of beads and other glass trifles—a rather good bargain, it may be observed. The Bissagos of this village have the evil reputation of being thieves and of having no sense of honour. They are also said to be treacherous. I must, however, confess that I had no reason to complain of my reception. It is true that I was always careful to approach the king before anyone else with a present of tobacco, powder, and brandy, or other merchandise. This present invariably assured my immunity from plunder.

Bâhn.—The trade here would consist mainly of palm-nuts and palm-oil.

Mdêne.—Bullocks and goats, hides and skins form the staple trade of the village.

Bâmé.—Here, again, we find the universal goat; paddy, as well as cleaned rice, and oranges are procurable.

Amboudouko.—The fisheries here are of considerable extent. All along the coast very excellent dried fish are procurable. The principal species is the mullet. The natives split them in two and dry them in the sun. After being dried, they exude an odour far from agreeable to the olfactory senses, but they give a most excellent flavour to cooked rice.

Anhoumero.—The natives of this village are skilful in the art of carving miniature pirogues. I bought two large boxes of them which contained at least 100. When I returned to Sénégal the captain of an English mailboat took them off my hands at three times their value, and sold them at once to the passengers for double the money he paid me. Nevertheless, the passengers were delighted with their bargains.

This general summary of the villages will enable my readers to form some general idea of the internal resources of Kagnabak, which is considered a very fertile island. The soil, like that of the whole of Portuguese Guinea, is of two classes—argillaceous and arenaceous. There are no mountains to be seen anywhere, not even little hills; all is a uniform level. Nevertheless, at the entrance of each village one finds small, running streams, supplied by large subterranean sheets of water, whose existence and formation I attribute to the rains of winter. This is the more probable as it is remarked that these streams diminish in volume as the dry season advances.

The whole of the island is covered with palm-trees. This precious tree must not be confounded with its congener of Algeria, which produces dates, and consequently obtains the name of date-palm. The palm-tree of the Bissagos is a tree about 8 to 12 metres high, at the head of which bunches of spikes are produced, growing to the size of a man's head. On each spike are hundreds of small nuts, covered with a fleshy-red skin. The natives gather the nuts and throw them into a vessel full of boiling water. The red skin of the nut, under the influence of water and heat, throws off a quantity of oil of a brick-red colour, which, of course, rises to the surface. This, under the name of palm-oil, is in great demand for various industrial arts at Liverpool and Marseilles.

When the nuts have been deprived of their skin they are set aside to be broken up by the women and children of the village, who extract from it a hard oleaginous kernel well known in all the markets of Europe under the name of palm-kernels. (This is, in fact, what in the cocoanut oil trade is known as "copra." Trans.)*

All the villagers possess herds of bullocks, pigs, and goats; in fact, the flocks and herds are the only sign of wealth. A king without a herd is a poor king indeed.

It seems almost superfluous to remark that coined gold and silver are quite unknown amongst these islanders. A native will sell you a fowl for four leaves of tobacco, and would refuse an offer of ten gold pieces for the bird.

In this island, as in all the others composing the archipelago, the cultivation of rice is carried on to a greater extent than that of any other field produce. The natives sow it in May and June, and it is ready for harvesting in October and November. The soil is well suited for this grain, and the Bissagos rice has the reputation of being the best on the whole Guinea coast.

Like the palm-nut cracking, the decortication of the paddy is carried on in a most primitive fashion. After it has lain exposed for drying to the sun's rays, it is placed in a mortar made of hardwood, and the women, armed with a pestle of caïlcédra, pound at it until the grain is perfectly free from its husk. I now give the products of Kagnabak in order of their importance:—Copra or palm-nut kernels, rice, palm-oil, oranges, bullocks, pigs, goats, bananas, mangoes, pine-apples, manioc, grey beans, mats, dried fish, palm-wine, monkeys, grey parrots.

All these products are partly consumed by the natives, partly exported to the markets of Bolama and of Bissao. The export trade is carried on by means of the famous Bissagos pirogues, which are from

* M. Olivier, Viscount de Sanderval, M.G.S. of Marseilles, whose name constantly occurs in connection with the Bissagos and Foulah-Djalou, invented a machine for breaking the palm-nuts and easily extracting the kernel. But the Bissagos are so ignorant and brutalised that it has been found impossible to induce them to make use of this ingenious apparatus, which in one hour will perform an amount of work which would employ a man working with a hammer for fifteen days.

40 to 50 feet long, and are propelled by fourteen oars a side. During war time these pirogues are the dread of the rest of the negroes of the Guinea coast, as the Bissagos of Kagnabak make no scruple of attacking every vessel they meet.

I left Kagnabak on the 11th July, the whole population being assembled to see me off. The king overwhelmed me with presents, and particularly he gave me one bullock, two goats, twenty fowls, four bushels of clean rice, two turtles, and two gazelles. I also carried away a small cargo of copra in exchange for a portion of my "trade," and when all came to be reckoned up my expenses had only reached 500 or 600 francs. I arranged with Tayacouané that, with the consent of the Société Flers-Exportation, we would establish a trading station on the principal island; and everything being settled satisfactorily, I made my final adieux, and set sail for Bathurst, the capital of Gambia, where I arrived on the 20th, having experienced no misadventure greater than some damage to the vessel's rudder. Three weeks later I returned to France to enjoy a short season of repose before setting out on another exploring expedition.

10.—A VISIT TO TOKELAU, UNION GROUP.

By Rev. SAMUEL ELLA.

11.—OCEAN CURRENTS: BOTTLE RESULTS.

By CLEMENT L. WRAGGE, F.R.G.S.

12.—MATABELELAND.

Communicated by Dr. L. S. JAMESON, C.B., Administrator British South Africa Company's Territories.

13.—AFGHANISTAN.

By Dr. JOHN A. GRAY, late Physician to the Amir.

14.—BORNEO.

By EDMOND LLOYD-OWEN, C.E.

15.—CAMPAIGNS AGAINST ARAB SLAVERS IN THE CONGO FREE STATE.

By BARON DHANIS.

16.—HAWAIIAN REVOLUTION.

[*Communicated.*]

17.—TERTIARY HISTORY OF PORT PHILLIP BAY.

By G. S. GRIFFITHS, F.G.S

18.—SOUTHERN ALPS OF NEW ZEALAND.

By A. P. HARPER.

19.—OCEAN CURRENTS.

By Commander PASCO, R.N.

Section F.

ETHNOLOGY AND ANTHROPOLOGY

1.—SUPERSTITIONS OF THE WEST AFRICAN TRIBES.

By Professor R. O. GARNER, Pittsburg, Pennsylvania.

No God; no spirits; no idols; witchcraft; fetishes; medicine; *Yassi;* masks; fear; the moon; the future; death; the resurrection.

It is often said that all tribes of the human family believe in a Supreme Being of some kind, and have some form of worship; but the facts do not sustain the proposition.

Among the African tribes living near the equator, on the west side of the continent,* there is no trace of a belief in anything having the attributes of deity; nor is there in use among them any rite or ceremony that suggests the idea of worship, sacrifice, or devotion to anything superior to man. It is true that they believe in witchcraft, but that cannot be regarded as belief in deity. All fear is not superstition, and all superstition is not a belief in deity.

They believe that certain persons possess some secret power by which they accomplish certain strange things, but they do not believe this power is inherent in the person who possesses it; they ascribe it to the use of some "medicine" employed by him, but they do not regard the "medicine," or the one using it, as of divine or spiritual origin. The fears they entertain are purely of a physical kind. They fear injury to the body at the present time; they fear sickness or death as the result of the use of "medicine," and they shrink from it as other animals do. The native does not believe that there is any power in the ceremonies and incantations used with the "medicine," nor does he believe that the person using it imparts to it any power of good or ill. He believes the "medicine" itself possesses some secret power, but he cannot conceive of such power existing apart from the "medicine."

Their faculties of abstraction are too feeble to allow them to form the faintest conception of a spirit apart from matter; and all their conceptions are of the materialistic kind.

The word *m'buiri* in their language, which is commonly rendered by the word "fetish," signifies mystery, strange; and anything which they cannot explain they call *m'buiri.* The word has no reference to the cause of the phenomena, but all things which they do not understand are said to be *m'buiri;* however, they do not imply by this word that there is a Supreme Being, or any being superior to man. It simply means that they cannot explain the cause.

They have great faith in the power of certain charms and amulets, but it is not so absurd as some of our own ideas of the powers of darkness, because they base their faith on the concrete and not on

* Near the Gaboon and Ogowé Rivers.

the abstract power. They believe that the claw of a leopard worn on the arm or the neck is a safeguard against the dangers of the forest, because it is part of a beast that all things in the forest fear, and the sight of it inspires terror in anything that sees it. The tooth of a crocodile is a powerful charm against the dangers of the water, for the same reason; but it is not believed that the claw or the tooth possesses any real power within itself, only that it suggests the strength and ferocity of those creatures to anyone who beholds it.

I brought home with me a fetish which is known as the most potent of any among them. It is the tusk of a young elephant, in the cavity of which is some hair from the head of a white man, a bit of human flesh, also said to be that of a white man, some large snake teeth, the point of a leopard's claw, a fragment of the tooth of a crocodile, a few small seeds of the plant from which they make the poison for arrows, all mixed in a kind of paste, which is said to contain certain properties that impart great strength to man. To these is added a little gunpowder, and a few drops of poison from a small snake whose bite is always fatal. This gruesome compound is all held in the cavity of the tusk by a fragment of glass broken from the side of a gin bottle. The efficacy of this "medicine" is largely enhanced by its being visible through the glass, and the sum of the matter is that the combined efforts of this fetish can subdue the terrors of the jungle; but the power of the charm resides in the things from which the parts are taken, and are all natural powers. Each one of these things can inspire terror in something else; but when combined there is nothing that would not fear them. In the native philosophy it is supposed that all these things unite their strength in one common effort of attack or defence. The result would be that the strength of the elephant, the stealth and venom of the snake, the ferocity of the leopard, the invulnerability of the crocodile, and the wisdom and prowess of man, with his arrows and gunpowder, are all combined in a single being; the idea is to combine and include all these things in one. What could hope to contend with success against a foe having all these powers combined?

When the hunter goes into the forest he swings this fetish under his arm, with the open end of the tusk forward, so that anything observing his approach may see the contents of this *m'buiri*.

The tribes differ slightly in the extent of the power they attribute to these things; but in no case do they believe in a being higher than man, nor any other than a natural physical power.

In every tribe that I visited, I found a belief in some mystic power, by means of which crime could be detected, sickness warded off, and death averted, and this secret is often brought into requisition. The power itself and the person in whom it is vested are jointly called by some name which implies *m'buiri* or mystery, and the same term is used to imply "power over witchcraft."

In some tribes the name is *Yassi*, in some *m'buiri*, in others *coma*, and so on. No one is believed to possess the power within himself, but with the aid of the "medicine" anyone can perform the same feats. One of the chief functions of this incarnation of mysticism is to detect criminals; the manner in which it is done is both interesting and logical.

When a crime is committed in any town and the author is not known, the people make a big *kanjo* or dance, and send for *Yassi*. He lives far away in the depth of the jungle. *Yassi* is only a man; he lives and dies like other men, hungers and thirsts, eats, drinks, and smokes as other men do. He can kill any man that provokes him, but is himself invulnerable. The people of the town cannot communicate directly with him, but they must go to the nearest town and get the people there to secure his services for them. When *Yassi* comes to the *kanjo*, every person who lives in the town must be present. When all are collected in a semi-circle, the performance begins, and *Yassi* emerges from the forest and enters the town. He always wears a hideous mask of wood, surmounted by great long tufts of hair made of bark or grass, and a long shaggy beard made of the same; while his person is concealed under a garb made of grass, causing him to look immensely large. Even his fingers and toes are concealed to avoid identification.

In one hand he always carries a spray of *m'bundo* (the plant from which is brewed the deadly draught used as the crucial test of guilt), and this fatal poison is feared by every native. In the other hand he carries a huge knife or stick, which is called *ereri kamba*—that is, a stick to talk, as no man is allowed to speak in their meetings without this stick in his hand.

After *Yassi* has hopped or danced about the ring for a short time, he begins in a very deep and solemn tone to tell them of the crime that has been committed in the town, and states the penalty of it. Holding aloft the spray of *m'bundo* to remind them of its fatal power, and how certain it is in finding out the guilty, he continues in a kind of chant, and passes around the circle watching the countenance of each one, and from time to time in the midst of his story flouts the *m'bundo* in the face of anyone he may suspect, and watches the effect produced. His own face is concealed by the mask, and no one can tell who it is; but their faces are bare, so that he can see them through the eyeholes of the grotesque mask.

Yassi has many points in his favour, and sometimes will detect the guilty one with little difficulty, but if he fail to find him that night he will leave the town and return the next night; then he prophesies that certain things will come to pass before his return. His prophecies are always safe because they are so vague and ambiguous, and anything that happens may be regarded as the fulfilment of them. For example, he predicts that a witch will shoot the criminal, and that the powder will settle around his heart, burn it to a cinder and turn it black, dry up his blood, and suffocate him in his sleep; his eyes will ache and burn, and his throat will feel dry unless he walk three times around a certain house. Should he attempt to do that he is at once suspected, and the people are watching to see if anyone approaches the place. It is believed that a witch can shoot without being heard or seen, and as there is no way to see the man's heart you cannot prove that it is not black and dry, and having faith in such things as these it is certain that one with a guilty conscience is liable to have all these symptoms before morning. Sometimes *Yassi* predicts that the guilty one will eat something that will lodge in his stomach and begin to grow, that it will turn his blood into water, causing it to dry up; his side will begin to pain him, and get worse and worse until he will fairly howl with it, but no one must go to his relief, because in doing so he will contract the same trouble, and after infinite torture will die an awful death, simply writhing in pain and screaming in vain for help.

If the guilty person will go to a certain tree, pluck three leaves and eat them, it will relieve the pain. But who dares to go to the tree? That would be conviction itself. With these prophecies hanging over the guilty head it is not difficult to imagine how that conscience would wrestle with the god of sleep. If he should go to pluck the leaves he is at once detected, but if not then come pain and rture and death. In either case he would have more strange feelings about his stomach than he ever had in his life before.

As a rule the guilty one is found out before *Yassi's* return; but if not, then some other ruse is tried until he is found. It is a clever piece of detective work well carried out, and I have sometimes half suspected that Lorenzo Dow was guilty of infringing *Yassi's* patents. The natives do not believe that *Yassi* without his mask is anything more than any other man, but with it he has the power of *m'buiri.*

In mental stature these simple people are but little children, and to them the mask transforms the wearer into the real, hideous thing they see before them. They cannot conceive of the person behind the mask remaining what he was before, but they do not believe him to have been transformed into a god. They fear him as a physical terror, but do not attribute any spiritual power to him.

Even the dogs of the town partake of the fears that seize the people, and that inspires them with more if possible. Indeed, *Yassi* is grotesque and ugly enough, and would impart terror to the most intelligent people with delicate nerves. I have seen ladies quite overcome by sights of much less frightful aspect, even after seeing them put on. Children always fear masks; and when a person puts one on, it imparts life to it, and it becomes too real to regard with indifference. When not worn they do not appear at all the same to anyone. It is a common thing in Africa to see one hanging up in a town, and the people have no fear of it. They know what it is, and for what purpose it is used, but when *Yassi* puts one on it becomes *m'buiri.*

It is very difficult to draw a sharp line between fear and superstition, but, so far as I have been able to determine, none of these tribes regard *Yassi* or any of his powers as being more than man.

The native African does not believe in spirits as we interpret the term. They have no conception of the soul without the body, and their notions of the dead returning to life are all materialistic. It is true that they believe the dead may revive, but they do not believe that the soul survives the body.

I once asked a man of the Orungo tribe what became of man's body when the body was dead? He sat for a moment in deep thought, then picked up a splinter and lighted it in the fire. After it had burned for a moment he blew out the flame and said, "Be man, 'e finish."

They are aware that men have died and after a time revived; but they do not know how long such a thing is possible.

Some of them said to me—"If a man can die when the sun catch here" (pointing up into the sky, at a point indicating about 10 o'clock), "and come back when the sun catch here" (pointing to another place indicating about 1 or 2 o'clock), "then he may die when the sun catch here" (pointing to the east); "come back when the sun catch here" (pointing to the west). "If he can do that, he may come back at any time."

So far as they know, such a thing may be possible for years, and hence they fear the dead; but they have no belief in the future state of the soul, and to them such a thought is utterly impossible.

The doctrine of the Trinity does not appeal to them, either as a fact or a fallacy; they do not grasp it at all; it simply makes no impression on them, because it involves the power of abstraction in too high a degree. The idea of omnipotence, omnipresence, or eternity is simply a universal blank without a shadow.

They have no theory as to the origin or destiny of man, or any other creature; they have no belief regarding the creation or collapse of the earth; they have no thought of the beginning or end of time or nature; they have no traditions connecting them with the past or promises for the future; the present is the only grand division of time in their chronology. Such problems never arise in the African mind; the African never asks himself such useless questions; he never had any reason to inquire. To him it is clear that all men were created in the same way, and all of them die in the same way, and that is the end. Many natural phenomena appeal to their fears, and they have some strange opinions regarding them.

I once spent some days in an Orungo village, and one evening about dusk I heard the sound of a human voice at the other end of the town. In a moment it was followed by a perfect chorus of voices, screaming in a peculiar manner, accompanied by the clapping of hands. I stepped out of the house where I was to ascertain the cause, and found the people in the open plaza screaming and clapping their hands at the moon, over which was passing a small, fleecy cloud. On inquiry I learned that the cloud was *m'buiri*, and when seen in that manner the people regarded it as a bad omen for their town, and they screamed and clapped their hands to drive it away. When the new moon's face was again free from the cloud the people rejoiced, and told me it was good for them, and that the moon would like them and give them light because they had driven away *m'buiri*.

On one occasion I was in a canoe in the Bay of Manji; it was quite dark, and the water was smooth and still. At each stroke of the oar there was a display of phosphorescent light in the salt water. It was bright and beautiful as it broke into fragments, glancing and whirling in little vortices at the side and in the wake of our canoe. I asked one of the natives what caused this strange sight, and what the lights were made of? He explained to me that it was the "moon's fire"; but I insisted that there was no moon, and he kindly proceeded to enlighten me about moons and moonlight. I thought what he told me was one of the most natural solutions possible to the simple mind, and at the same time quite poetical.

He said: "The moon does not stay at Manji all the time, but he keeps his fire in the water of the bay, so that he can get it when he wants it. He comes and goes at intervals. Sometimes he only uses a small bit of fire, and at other times a great deal. When he uses much fire there is but little of it in the bay, but when he is not using much there is plenty, plenty, and to-night he is not using much, so there is plenty in the water." I asked him why we could not see it except when we stirred the water, and he said: "The fire is asleep in the water, but when the boys stir it with the oars they disturb it, and it wakes up and runs away." At this juncture he pointed his finger at a glittering swirl made by one of the oars, and as it receded from us he said: "Look 'im, 'e fear, 'e run"; then waving his hand over the dark silent water he said: "Plenty fire fer dem water, but dis time he sleep." I asked him how the moon got the fire out of the water and took it up into the sky, and he said: *M'buiri*, meaning, it is a mystery that cannot be explained—that is the moon's secret.

As a theory I regard this as logical and unique; it is a verdict given in accordance with the evidence, showing how closely the facts have been observed. For it is true that the lights in the water are always in an inverse proportion to that of the moon, and the darker the night the brighter the phosphorescence. But the natives do not regard this light as of divine origin. To them the moon, the water, and the light are all material realities, but their conduct is *m'buiri*, fetish, secret. It is true they have many signs and omens, but they do not amount to a belief in any kind of deity; there is no trace of any belief in Heaven. In their theology they have no hell or purgatory, nor any use for either; no future rewards or punishments, and no dream of ever meeting again after death. When such an idea is advanced to them it strikes them as novel and absurd.

These people have no idols, but they have images which have been mistaken for such, and columns of stuff have been written about them.

I spent four or five days in a native village, where one of these so-called idols is kept, and made a careful search into the belief of the people concerning it.

The image occupies a conspicuous place in the town, and is supposed to protect it against thieves. It represents *Yassi*, and is a composite figure, combining both sexes. I asked many questions about it from day to day, and received much information concerning it and the thing it represents. It is a crude image made of wood. From the waist downward it represents a man, while the body is that of a woman, with the head of a man. The whole figure is painted a dingy white, with black hair, moustache, and a spot on the chin for a goatee. The artist appears to have selected a French type or model. The eyes are black, and above them is a black double-curved line across the forehead. Around each breast is a circle of black, and one around each arm. The image stands on the bank of the river, and no one could land a canoe without seeing it.

The sum of what I learned about it was this:—The image has no power within itself; it is simply wood; but if a thief came into the town to steal he would see this image, and it would remind him of *Yassi*, and *Yassi* can detect a thief. If detected, he must drink *m'bundo*, and then he will die, for no guilty man can drink it and live. It is simply a warning to the intruder; it is not fetish; has no power; is not sacred; receives no devotion; but is valued for the services it renders the town, in the humble office for which it is designed.

The same is true of the figures carved on the bows of their canoes, for which they usually select the head of a crocodile, a turtle, or some other aquatic animal, which is designed to inspire terror in the denizens of the water.

Fear is not evidence of a belief in deity, and the fear of the poor savage—fear which he cannot explain—does not argue that he regards the object of his terror as a god. He fears snakes, he fears leopards, he fears thunder and lightning, but he does not fear anything which he does not know to exist. His belief is circumscribed by his experience; and beyond that he does not speculate or theorise.

Many things are *m'buiri*, but nothing is supreme in its true sense. Savages fear death as other animals do, but it is no evidence of their belief in a deity; and they believe that certain persons can cause death by witchcraft, but they attribute it to some physical agency under their control. They believe that *Yassi* can detect a criminal, but they ascribe it to his "secret" and his "medicine." They believe that he cannot be killed by any other man, although he is born as other men, and will die as other men; they have always heard that it would be fatal to try and kill him or harm him, therefore no one ever tried to do so; but all this is due to his "medicine." Deprive him of that, and he is the same as other men. No witch has any power except the "medicine," and with that anyone can do the same thing. It is a chemical secret; it is the same as "patent medicines" with us.

The art of reducing iron ore is a secret, and those who possess it are *m'buiri;* they will not divulge it because it is a source of profit to them, and by it they monopolise the iron traffic of their tribe, but it is not regarded as a divine power. The process of making steel was long kept a profound secret among us for the same reason, but it was not regarded as divine, although mysterious.

Among the Esyira people the man who knows the secret of making iron is a great man, but they do not believe him to be any more than man. As I went through the tribe, I tried to learn their method of reducing ores, but failed to get any clue to it. I learned that I might obtain the secret for *siku*—that is, for "wealth." I did not wish it for my own profit; I merely wanted to compare notes with them, as I knew the process used by white men, but they simply smiled at me, and thought I was trying to extort their secret for my own use.

They see no mystery in the growth of plants, in the solar system, in procreation, or in any process of nature, unless it is rare or violent. They see no mystery in the gentle sunshine, but the lightning is *m'buiri;* in the soft breeze that fans the arid plain there is no mystery, but the tornado raging in the forest is *m'buiri;* in the quiet waters of the lake there is nothing strange, but when it breaks into waves it is *m'buiri;* in sleep there is no mystery, but death is the great *m'buiri.*

They have no faith in the resurrection of body or soul, but they fear the return of those who have not completed the act of dying. They believe that people die from witchcraft by degrees, and that they are sometimes dead while they are yet residing in the town; that is, that the power of the witch has taken effect, and the victim is insensible to all around him; he may talk and laugh, but he is devoid of feeling; he may sit or walk, but with no motive in doing so; he is dead to everything except the power of the witch; but his life is yet in his body. This paradox is only one of many such among them.

They fear death, but not the future. They have images, but no idols. They have ceremonies, but no worship. They have material agencies, but no spirits. They have mysteries, but no gods.

2.—THE ANCIENT SAMOAN GOVERNMENT.

By the Rev. S. ELLA.

A mistaken notion prevails that Samoa had no settled government and was without any political constitution, and that a state of anarchy and lawlessness characterised its people. This error arose chiefly from the constant intertribal wars which distracted the country, and the slight amenity to law manifested by the people. The fact is an established constitution existed from ancient times, but foreign powers have ignored the native constitution, and sought to establish a policy of their own construction, and their injudicious interference has aroused resentment and opposition in the minds of the natives. Much of the disquietude which has recently prevailed might have been averted had an effort been made to ascertain what constituted the native policy, and how their ancient customs and *régime* could be regulated so as to give satisfaction to the people, and maintain a government on their own principles. Instead of doing this the Americans, in the first instance, with Steinberger as their tool, sought to found a government which promised to be most favourable to their nation; and afterwards the Germans, having large commercial interests in Samoa, remodelled the plan more in accordance with their views. They deposed and exiled the king, and placed another claimant to sovereignty in his room. This step gave umbrage to the majority of the people, and especially to the ruling chiefs of Atua, the eastern division of Upolu, who then put forward the high chief Mataafa, as possessing the stronger claim to be made king of Samoa. To understand aright these conflicting claims, and to perceive clearly the blunders committed, a review of the government of Samoa from ancient times will be helpful.

The earliest form of government appears to have been patriarchal. The chiefs were the heads of families or leaders of expeditions which first occupied the land. There is no tradition or legendary trace to show that the country was inhabited before the present race occupied the soil, yet there are some vestiges or signs which indicate that other races existed in Samoa prior to the advent of the present. As families increased, the heads of families were called *tulafale* (foundations), and they appointed their head of clans, *ali'is* and *faipules* (chiefs and rulers). These, too, after a time varied in rank and influence according to differences in their family descent. When Samoa became divided into distinct districts or states, a head chief of each state or division was appointed and recognised as king or lord of that division, and received the title of *tui*, synonymous with king. The most potent and influential of these were the *Tui-Atua* and *Tui-Aana*, ruling over the eastern and western divisions of Upolu. The central division of Upolu, Le Tuamāsanga, although possessing no chief with the title of *tui*, yet administered the same rights and authority through their supreme chief of the head village, which took the title of *laumua* (the fore-rank). Savai'i also was represented in the general government, under the name of *Le Pule-o-Salafai*, of which the town of Safotulafai, on the south side of Savai'i, is the chief land and seat of the authority. Besides these supreme chiefs there were others of high rank, distinguished by the title of *ali'i-paia* (sacred chiefs), probably so called on account of their holding the office of priesthood as well as chieftainship. I may here remark that it is difficult now to ascertain the origin of these names and titles. The genealogies now extant are in some instances confused and disconnected, more or less substantial or mythical.

The *tulafales* are the heads of families and land proprietors, and correspond with the *rangatira* of New Zealand. These hold great influence in the Samoan government. They have power to appoint and depose chiefs, though of late years this prerogative has been but rarely exercised. Occasionally chiefs were deposed and banished to the island of Tutuila. A *tulafale* was selected by the chief to act as his orator and prime minister.

The *ali'is*, or chiefs, are the heads of tribes or clans, and their position, though not absolutely hereditary, is maintained in the tribe by the general recognition of the *tulafales*. Much care is exercised to sustain and strengthen their position by suitable marriage, and a *mésalliance* always occasioned difficulty and a loss of dignity and prestige. A chief had power to appoint his successor, and this was often done in cases where there was no legitimate heir, or where the chief preferred another member of his family to the rightful heir, and in some cases in order to strengthen the position of his clan, by giving his title to the chief of another clan. Such appointments, however, had to be sanctioned by the *tulafales*.

Chiefs are of various ranks, and differ in distinction and authority. Some are termed *ali'i-paia* (sacred chiefs), and are of superior rank and influence, to whom very great deference is shown. They are a highly privileged class, and are beyond the influence of the *tulafales*, although they derive their titles from the districts they represent. Of the *ali'i-paia* are the supreme chiefs of the three divisions of Upolu: Atua, Le Tuamāsanga, and Aana. These possess special titles viz., *Tui* (lord or king) of the division, as Tui-Atua, and Tui-Aana. They are supreme in the land, and have power to make war or declare for peace. All the towns and villages of the district render allegiance to them.

There is no royal line in Samoa. A chief possessing all the high titles of the ruling districts became king or *Tupu-o-Samoa*. The titles may be conferred on him at the disposition of the respective districts, or be secured by conquest in war. These titles are the *Tui-Atua*, *Tui-Aana*, *Le Tama-soāli'i*, and *Ngatoa'itele*, of Le Tuamāsanga, and *Le Pule-o-Salafai*, representing the whole of Savai'i. The present difficulty and conflicts in Samoa arise from the fact that Malietoa-laupepa, whom the three powers have recognised as king, has not yet received the titles of "Tui-Aana" and "Tui-Atua," and he is therefore viewed as a usurper by the districts of Aana and Atua. Tutuila and Manu'a are politically united to Atua. There is not likely to be any peaceful settlement or permanent submission to Malietoa until this rule is complied with. The mistake made by the representatives of the tripartite Government is that, instead of using a peaceful influence to obtain these titles for Malietoa, they have treated the Tui-Atua and Tui-Aana as rebels, and in the case of England and Germany have met the claims of Aana and Atua by armed resistance.

The dignity of chiefs was recognised by a court language; that is, certain words applied to them and differing from the ordinary terms used to commoners. Their rank was also distinguished by distinct words regarding their presence, speech, &c. These are *afio*, *susū*, *maliu*, and their derivatives, instead of the common words *sau*, *o mai*, and *upu*, employed in common usage. A chief never used the court language in speaking of himself, although it would be a serious offence and insulting to address him in the ordinary words. The Samoans are a polite and, in some degree, a polished people. They are very observant of delicacy in address and politeness in general intercourse, not only towards their superiors but also in communication with one another or with strangers. A commoner or a female always assumes a stooping or sitting posture in the presence of chiefs.

In their seats at councils and ordinary ceremonies and festivals their rank is distinguished by occupying the seat of honour. At native feasts they received choice portions, and the first cup of *kava* according to their rank, after the usual libation had been offered to the gods. Certain fishes, &c., were given to chiefs as their right, and were tabued to the common people.

The authority of chiefs in most cases was little more than nominal. They acted as magistrates and judges, as well as councillors and law-makers, but it was a difficult matter to maintain their laws or impose punishment for offences. A spirit of democracy has always characterised the Samoan people, yet the chiefs received a respectful deference from their clans, and they could exercise a moral influence upon their people. The *tulafonos* (laws of the council) were generally respected. In olden times, it appears, the authority of the chief was more arbitrary, occasionally tyrannical, and the *tulafonos* were more rigidly observed, and severe punishments followed any infringement.

Communities were distinct, and maintained their individual rights and privileges in what some would term enviable independence. They could combine for mutual protection, or for any object to promote the ends of the common weal. Such combination might assume the form of a state. They held their legislative assemblies, or *fono*, either in a council chamber, the *fale tele*, or *marae*, an open space in the centre of the village. At the *fonos* the chief highest in rank was expected to be the first speaker, either in person or through his orator, unless he chose to cede that prerogative to another, generally the next in rank.

The possession of land was not in the entire control of chiefs, but it was owned alike by the chiefs and *tulafales*, and neither party could alienate any portion without the concurrence of every member of the family interested. A violation of this rule would occasion difficulties that would involve the chief in trouble, sometimes occasion his deposition. This is a subject for consideration to foreigners in seeking to acquire land in Samoa. In some cases where the rule has been disregarded by them, the purchasers of land have found themselves placed in trouble with the natives, and their land-title disputed.

Genealogy of Chiefs.—In Samoa the genealogy of chiefs, especially of high chiefs, was preserved with great care, and the custody was committed to a select class, who were very careful and jealous of the honourable and responsible function they held. Of course, having no knowledge of writing, the chronicles were retained in their memories alone, and thus handed down from one generation to another. They were entrusted with the duty of instructing young chiefs in their genealogical history and chronicles. As aids to memory certain fine mats (*ie tonga*) were woven to commemorate important family events, and handed down as heirlooms in the family. In native genealogies of the kings of Eastern Polynesia it was a common custom to trace their origin to the gods or heavenly powers—like the Greeks and Romans and other ancient nations.

The common Samoan myth regarding the creation and peopling of their world assigns the first act to the god "Tangaloa," who, while fishing, hauled up a rock from the ocean deep, which afforded a resting-place for his daughter on a visit to the lower world. On a subsequent visit she found the rock covered by an ocean creeping-plant. The creeper afterwards perished and produced worms, and in the course of rapid evolution the worms became men and women. This myth varies on different islands. In the eastern islands there is an account of a succession of rocks which are personified, and the first man, *Le Tangata*, was the offspring of these rocks; he was also named "Tupu-fua" (arising spontaneously). He married a daughter of the supreme deity *Tangaloa-langi*. Their son, named Lu, became king of heaven. He descended to the earth, and a son was born to him who was called "Tui-Atua" (lord of Atua). He married his sister, "Langi-tuavalu" (eight heavens), and their son became a Tui-Atua. This is the mythical genealogy of the Tui-Atua; thence the table proceeds on a plain historical record.

The Tui-Aana sprang from the family of a high chief named Le Samoa-na-ngalo, who married the daughter of the King of Tonga. Their second son was Le Sanga-alala. In the genealogy of Samoa-na-ngalo it is recorded that, after several generations of chiefs who retained their separate chieftainships, a son was born to Tui-Aana-tama-a-le-langi, who was named Salamāsina, and in this son the several high titles (*ao*) of Atua, Aana, and Le Tuamāsanga were united, and Salamāsina thereupon became King (*Tupu-o-Samoa*). Then the title descended through the female line, and the genealogical chain passes on to Sina, a grand-daughter of Salamāsina. Her son was Faumuina, who retained the royal titles. The second wife of Faumuina was Ata-mu-lau, a Tongan lady. A third wife was Fala-leomalie, a daughter of Mata'utia, a high chief of Aleipata, a superior town of Atua. Quarrels arose among the children of these different wives, and the sons of Faumuina fought several battles. These quarrels caused a dispersion of the royal titles, which were redistributed to the respective districts from which they had been obtained, and for a time the kingship was loosely held, as none now possessed the united titles, and therefore were not recognised by the respective divisions of Samoa. In this state of things wars were frequent in the struggle for supremacy; and Fonoti, the son of Faumuina and Fala-leomalie, became King by conquest. Fonoti married Fuatino, a chief lady of Fasito'otai, in Aana, and their son was Muangututi'a, who became a high chief of Aana, and by marriage a high chief of Atua also. Their son was Tupua, who became Tui-Atua. Mataafa is a scion of this house. Afoa, the eldest son of Tupua, became King, but Ngalu-ma-le-mana, another son of Tupua by a second wife, won the regard of the *tulafales*. Afoa sought to raise troops against his brother, but was defeated. Ngalu-ma-le-mana then became King, and held all the Royal titles—"Tui-Atua," "Tui-Aana," "Tama-soāli'i," and "Ngatoa'i-tele." Family discord broke out anew, and a succession of sanguinary conflicts ensued. Mataafa was deserted by large numbers of his followers; but Nofoa-saefa, the son of Ngalu-ma-le-mana, was supported by Aana, Le Tuamāsanga, and Savai'i, and conquered Mataafa. He, like his father, received all the Royal titles. On the death of Nofoa-saefa, Atua was divided in the choice of a successor. At a general council (*fono tele*) I'a-māfana was selected, and proclaimed King, and had all the titles, being sustained by Aana, Le Tuamāsanga, and Savai'i. On the death of I'a-māfana. other wars broke out; and during the disturbances a high chief and priest of Manono, Tamafainga, was proclaimed King, although he did not possess the titles to constitute his authority. He was superstitiously regarded as a god, and was viewed with great awe. He became an intolerable tyrant, and his cruelties and oppression provoked Aana to rise against him and kill him. Manono and Savai'i united to avenge the murder of Tamafainga, and were joined by Atua and Le Tuamāsanga. Malietoa, a high chief of Savai'i, was then proclaimed King, the first of his family who made any claim to this dignity. At his death his brother took his name, and assumed his authority, contrary to the expressed desire of the elder Malietoa; a part of Le Tuamāsanga was the only division of Upolu which recognised his claim. Repeated and long-continued conflicts have prevailed ever since this event. Foreign influence was brought to bear upon the people to establish peace and a settled government. Germany deposed Malietoa-laupepa when he was likely to receive the requisite concession of titles, and set up another claimant, Tamasese, a son of Moengangongo, of Atua. He was supported by part of Aana also; but Mataafa, a descendant of Mua-ngututi'a, and the recognised Tui-Atua, opposed the appointment of Tamasese. The Berlin Council of the three powers—England, Germany, and America—reinstated Malietoa-laupepa, and required the whole of Samoa to submit to him. This would probably have been done but for their interference. Native jealousies were aroused and intensified by the imposition of objectionable taxes for the support of foreign officials, and this opposition was accentuated through the severe measures used to enforce the taxation.*

I will conclude this paper with some valuable MS. notes on the Samoan Government supplied me by the Rev. J. B. Stair, of St. Arnaud, Victoria, who was a missionary in Samoa more than fifty years ago. He says:—

"Until a comparatively recent period the government of Samoa appears to have approached more nearly to that of Tahiti and the Sandwich Islands—viz., monarchical—than might be supposed from the confusion that has prevailed there of late years. Possibly it may be

* In the second volume of this Society's Proceedings will be found very full genealogical tables of the Kings of Samoa and Rarotonga. I would recommend a reference to these for further information on this subject.

described as having been a combination of the monarchical and patriarchal form of government, since, although for many generations past the whole group was governed by one head, *O le tupu* (king), in whom the supreme authority was vested, the different districts were governed, to a great extent, by their own local authorities, chiefs, and heads of tribes, these being in many respects independent of each other; yet, at the same time, they acknowledged the supreme authority of the *tupu*. This regal or highest title of all, *O le tupu* (king), was acquired by the possession of the following titles (*ao*) in the gift of four districts, comprising the whole of the two principal islands, Upolu and Savai'i, viz.:—1, *O le Tui-Aana*, in the gift of Aana; 2, *O le Tui-Atua*, in the gift of Atua; 3, *O le Ngatoa'itele* and *O le Tama-soālii*, in the gift of Le Tuamāsanga; and 4, *O le Pule-o-Salafai*, in the gift of Savai'i.

"When these *ao* (or titles) were centred in one chief, his power was great, and extended over the whole group, since, although Tutuila and Manu'a gave no direct title to the king, they were represented by Lufi-lufi, the *laumua*, or leading settlement of Atua. Manono also, though apparently not having any direct title to give on this occasion, was always consulted as to the bestowment of them.

"The *ao* (title) of Aana was usually bestowed first, and, upon this being acquired, the other districts followed suit, and sent deputies to confer their title and assist in proclaiming the king; and, when this was accomplished, it was said, *Ua tafa'i fā ua o'o i le Tupu* (four centre in one, he has attained to the crown). Upon this the chief thus honoured assumed the title of *Le Tupu o Samoa* (the King of Samoa), and shortly afterwards made a circuit of the islands that he might receive the homage and congratulations of the different districts. The announcement, *Ua afio mai le tupu* (the king is approaching), caused much excitement and stir in the several districts and settlements in the way of preparation for the visit.

"Following the title of Tupu comes that of *O le Tui* (or lord), which is always prefixed to the name of the district conferring it; as, *O le Tui-Aana*, *O le Tui-Atua*, &c. This is a much-valued title, but inferior to that of *O le Tupu*, or king.

"*Ali'i paia*, or *Sacred Chiefs*.—Some chiefs of high rank were termed *ali'i paia*, or sacred chiefs, to whom much deference was shown. There were twelve of these:—1, *O le Tui-Aana;* 2, *O le Tui-Atua;* 3, Tonumaipe'a; 4, Fonoti; 5, Mua-ngututi'a; 6, Tupua; 7, Ngalu-ma-le-mua; 8, I'a-māfana; 9, Tamafaingā; 10, Malietoa; 11, Tama-soāli'i; 12, Ngatoa'i-tele. These were all entitled to be addressed with the highest phrase—*afio*. Six other *ali'i paia* were addressed with the next highest title or style of address—'Sūsū.' These were:—1, Riromaiāva; 2, Mataafa; 3, Le Manu'a; 4, Fiamē; 5, Salima; and 6, Lavasii. To four other chiefs the highest style of address —*afio*— is appropriate, although they are not of the class termed sacred chiefs. These are:—1, Taimalie-utu; 2, To'aleāfoa; 3, Liutele; and 4, Afamāsanga. The *ao* (titles) of these chiefs were in the gift of various places, two of the districts sometimes having the same, whilst Manono managed to monopolise three.

"The following are in the gift of the undermentioned places:—

Ao, or Title.	By whom Bestowed.
Pe'a, or Tonumaipe'a, and Manupunafanua	Satupaitea and Manono
Riromaiava	Safotu, Sasava, Palauli, and Nofoa
Tui-Aana	Leulumoenga, or Aana generally
Tama-soāli'i	Le Tuamāsanga and Safata
Ngatoa'i-tele	Sangana, Tuisamau, Lea-auimatangi, and Laumua
Mataafa	Faleata
Tui-Atua	Lufi-lufi and Atua generally
Le Manu'a	Sanapu and Safata
Fiamē	Samatau
Salima	Vailele
Lavasii	Le Fagā

"The power of the *tupu* (king) was despotic, and was at times exercised in a most oppressive manner; but the *tulafale*, or land-owners, with whom the gift of the *ao* (title) lay, were a great check upon any despotic proceedings, and they did not fail to exercise it, even at times deposing the king.

"*Principal Families.*—There are three great families which comprise the aristocracy of Samoa, whose ramifications spread over the whole group, and to one of which every chief is referable, whatever his rank or title may be. These are Sa Mataafā, Sa Malietoā, and Sa Muangututi'ā. I am not certain if this statement holds good as regards Manu'a, but I rather think it does. For a long series of years the possession of the much-coveted title *O le Tupu* was confined to members of the last-mentioned family, Sa Muangututi'ā; the last six kings who bore the title, inclusive of the first Malietoā, being Muangututi'ā, Pa-māfana, Nofoasāifa, Safeofafine, Tamafainga, and Malietoa-Tavita. Safeofafine was the last of his line, the family of Muangututi'ā; and after his death the office remained vacant for a time, until it was obtained by a *taulaaitu* (priest) of Manono, called 'O le Tamafainga,' who not only assumed the office of a king but also the attributes of a god. He was a terrible tyrant, and, from his being worshipped as a god, he possessed immense power and influence; but his tyrannies were so intolerable that the people of Aana, who had at the first conferred their *ao* (title) upon him, rose against him and killed him in the year 1829, just before the introduction of Christianity to the islands. A fierce and bloody war broke out soon after the death of Tamafainga, in which Aana was defeated and for a time crushed; but the group was rid of a tyranny that was unbearable. Tamafainga was succeeded some time after by Malietoa, the first of his family who had ever been raised to the dignity of *tupu;* but his power and influence, although considerable, were inferior to that exercised during the reigns which preceded the usurpation of Tamafainga. He had laboured hard to get possession of the much-coveted dignity; but he did not long enjoy it, and at his death he adopted the somewhat unusual course of apportioning out the various titles (or *ao*) which had been conferred on him, thus trenching upon the jealously guarded privileges of the *tulafale* of the different districts. They refused to ratify the expressed wish of the old king and left the office in abeyance. The first Malietoa made no secret of his wish that, as he was the first of his family who had obtained the dignity of *tupu* or king of Samoa, no other *tupu* should be chosen after him, but that his name might descend to posterity as the last king of Samoa.

"Malietoa's wish seemed at one time in a fair way of being granted; at all events he was the last king unfettered and unhampered by outside influence. At the time of his death there were many candidates for the vacant honour, and so many difficulties presented themselves that the parties having the power to bestow the various titles so as to confer the dignity refrained from doing so, or even from acceding to the old chief's wish that his several *ao* might be divided among the three relatives he nominated. His brother, Tai-ma-le-langi (Sea and Sky), succeeded to the family name of Malietoa, and was acknowledged as Le Tupu-o-Salafai (King of Savai'i), but Aana and Atua refused to acknowledge the claims of the aspirant to their *ao* (titles) further than as a matter of courtesy. Later on they seem to have united and conferred their *ao* upon a succeeding Malietoa, and thus rallied for mutual defence in the face of outward pressure; and when their king was forcibly deposed, and an outsider and tool exalted to the dignity, the spirit of the people was stirred, and Mataafa, one of the three great families of the group, was either forced or allowed to go to the front and form a rallying point against their oppressors."

3.—NOTES, CHIEFLY ETHNOLOGICAL, OF THE TOKELAU, ELLICE, AND GILBERT ISLANDERS.

By Rev. J. E. NEWELL, London Missionary Society, Samoa, South Seas.

The following notes are the result of personal inquiries and observations made during two brief visits to the islands in 1885 and in 1894. They are necessarily brief and discursive and incomplete. The time spent at each island was largely occupied in missionary work, and would, apart from that, have been much too short for detailed inquiry into the legendary history and folk lore of the people occupying this section of the great tropical belt that encircles the earth.

The information, such as it is, was obtained from the most intelligent and reliable native sources, with the help of the resident Samoan native teacher.

I. The TOKELAU, or Union Group of Islands, consists of three groups of islets or atolls named respectively: Fakaofo (or Bowditch Island), Atafu or Atahu (Duke of York Island), and Nukunono.

Of these, the last named has not been visited by the writer, and is only casually referred to in these notes.

Fakaofo—situated about Lat. 9° 26′ S., Long. 171° 12′ W.—is the name of a group of some thirty islets enclosed by a reef inside a lagoon triangular in shape, and about 20 miles in circumference.

The principal islets are named Fale, or "the house" or "home"; Nukumatau, "right hand" or "easterly island"; Nukulakia, or "westerly island"; Fanualoa, or "long land"; Sakea; Te atu; Motu, or "the group of islands"; Matangi, or "windy" island; and Fanuafala, or the land of *fala* or pandanus fruit.

The last is so named from the qualities of the soil, this being the only island in this group of Fakaofo upon which the much-valued edible pandanus will grow.

The name "Fakaofo" is said by the people themselves to have been given by the original settlers to the small island afterwards known as Falé, upon which at the present time the whole of the population reside. The name is explained as meaning "high or raised platform," and would exactly describe the appearance of the island, which is, in fact, a raised coral platform from 10 to 15 feet in height, and some 500 yards in length.

But, if this were the derivation of the word, it would appear not as "Fakaofo," but "Fataofo," from *fata* — a shelf or raised platform, and *ofo* — to be surprised. As everything else points to the Samoan origin of the people, the name given to the first settlement would almost certainly not appear as "Fakaofo," with the *k*, at a time when there is no other evidence to show that *k* had begun to be substituted for *t* in the language.

It is not, however, allowed by the people that the alteration of Faka-ofo = Fa'a-ofo—"to cause surprise," has ever been suggested, but they will readily allow remote contact with Hawaii, of which, indeed, there is independent testimony.

The people are prohibited by a stringent *tabu* from occupying any other of the numerous islets of the group. This *tabu* has in later times taken the form of a regulation, with penalties of fines or hard labour, strictly enforced by the rulers.

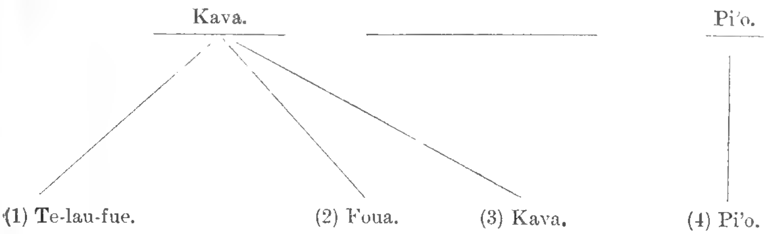
The prohibition is a necessary safeguard for the protection of the little community—at present numbering 264 souls—from the avariciousness of the few. It provides against stealing and any uneven and unfair distribution of their very limited food supply. The time and place for obtaining cocoanuts and pandanus is determined by the old men, who form the ruling body. The people then go forth in a body, and collect and bring home the needful supply from the family plot. Apparently the only people who feel the severity of the prohibition are those who have lived for lengthened periods in places so differently circumstanced as to food, as Samoa or Fiji.

Two traditions refer the original settlers to Samoa. In one the original settlers are said to have been a man and woman from Samoa named "Kulu" and "Ona." The other tradition mentions two brothers named "Kava" and "Pi'o" as the original owners of the soil.

The habits, customs, and language of the people confirm generally these traditions about their Samoan origin. Most of the variations from well-known Samoan customs are such as may be accounted for by the tradition itself, or by the fact of the early contact and intermixture of these people with other South Sea peoples.

An interesting tradition gives undoubted proof that the Tokelau Islanders were great navigators. The old King of Atafu recited an old song to me, which related the exploits of his ancestors on the sea in what were described in parenthesis (*i.e.*, as not embodied in the original legend) as vessels like the vessels built by "foreigners" in modern times. In these native-built ships those old sea-kings sailed without fear, under the protection of the great god "Tui-Tokelau," to Fiji or Tonga, steering their course by the stars. The all-powerful Tui-Tokelau infused his "mana" into these warriors, and they fought and conquered the Fijians in war. I did not myself see, but I had reliable evidence that until recently there were planks "two fathoms wide"—the remains of one of those old island canoes to be seen on Fakaofo. At Fakaofo, too, I heard that they had a tradition (which I could not obtain) of a war which had hundreds of years ago been waged between the Tokelau Islanders and the Tongans.

The so-called King of Fakaofo bears the title of "ariki" (Samoan, *alii* = chief), and is the only person until quite recently so described. The "ariki" is always the oldest male member of the four principal families of Fakaofo, all of whom trace their descent from the two brothers above referred to—namely, Kava and Pi'o. Their genealogical tree is thus given:—



When the "ariki" dies the oldest man then living among these four families becomes "ariki." No others possess this title, and there are no clan names or titles outside this circle. The Samoan custom of conferring the name of the head of the family upon the heir does not exist in the Tokelaus. No young man would under any circumstances become head of the clan so long as an older man was left to take the headship.

The old men form the ruling council, and are known as the "*Kau Kolomātua.*" With this name those who know Eastern Polynesian will compare the Samoan—*olomătua* an old woman, *olotu* an old pigeon; Eastern Polynesian—*oromătua* spirit of a deceased ancestor, and *oromĕtua* elder or wise man, example, &c.

The Atafu traditions take us further back into the region of cosmogony. The present King of Atafu traces his descent from Fatu, whose descendant or son was Singano (pandanus blossom), from whom came Kava and Vahefanua or Vasefanua (marker of boundaries). By Vasefanua came Pi'o and Tevaka; the only two families (says the Atafu tradition) bearing rank as chieftain.

Tevaka, like Pi'o or Piō, belonged originally to Fakaofo, but raised a war against Nukunono, which he conquered, and then proceeded to Atafu, which he also subjugated to himself. And here an interesting fact emerges—namely, that previous to the settlement of the colony from Fakaofo, as a consequence of the war under Tevaka, there were inhabitants of an allied race on the groups of Nukunono and of Atafu. At least, the inference is that such was the case on Nukunono, from the fact that there were people to fight with Tevaka. The tradition distinctly states that there were warriors organised under a chief on Atafu or Atahumea, as the group of islets is called in the legend.

On arriving at Atafu, Tevaka was met by a chief or orator named Malaelua, who had a celebrated warrior named La Fotu, famous for clever stratagem in war. This warrior was wounded in the combat, and the Atafu people were routed and had to take to their boats. Two of these boats made good their escape, and were afterwards heard of in Samoa, having landed at Sangana and Malie, on the Island of Upolu.

This tradition is confirmed in all its details in Samoa itself. At Malie the "failauga," or village orator, bears the name of Tuiatafu and his title is Auimatangi. In the Atafu tradition, which I received from the King of Atafu, the party who drifted to Malie, on Upolu, were met by the then reigning Malietoa, with whom they drank kava, and by whom they were received as guests. In the conversation which took place, Malietoa asked whence they had come, to which they replied they had come from Atahumea; and on being further interrogated as to *how*, they replied "*Ua au i matangi*"—driven by the winds.

I have already stated that these Atafu traditions take us back to remote cosmogony; at least this is the opinion of others who have heard fragments of these legends. *Fatu* means "stone," and *Vasefanua*, as I have said, "definer of boundaries," and *Singano*, "the pandanus blossom." But in some legends *Fatu* is said to have been changed into *Vasefanua*, who was the first man. (*Vide* Dr. Turner's "Samoa," chap. xxiii., for independent testimony.)

Atafu, like Fakaofo, is a group of islets, though they are fewer in number. It is a smaller group than Fakaofo, but very similarly dotted about in a lagoon, which is angular; the highest of the islets, appearing from 10 to 15 feet above the level of the sea, are situated at the angles in the lagoon.

Nukunono I have not seen except at a distance.

I am not in a position to add much to what Dr. Turner has written in the work above cited about the religious customs and beliefs of the Tokelau Islanders. The King of Atafu, and the oldest men I could find on Fakaofo, all declare as their solemn conviction to this day that Tuitokelau (literally, King of Tokelau) represents the Supreme Being, and was so worshipped. Dr. Turner says that Tuitokelau was both king and high priest. I was, however, informed that the king or "ariki" was not also "vakātua," or priest of the god.

It seems probable that the two offices were originally combined in one person, but that afterwards, as is now affirmed by the people of Fakaofo, the son of the "ariki" became king, but the son of his sister became priest.*

The priest's person was sacred, but he was not *pa'ia—i.e.*, he did work.

The story of the remarkable man Tuitokelau, who was deified as the great god, is, it is to be feared, for ever lost. His abode was Fakaofo, and his shrine was the holiest spot on earth to those who gave him homage. His spirit inspired their warriors with strength and courage,

* As we have seen, this law of heredity with regard to the office of "ariki" does not now obtain on Fakaofo. I transcribe the exact words of the statement made to me about the offices of king and priest: "O tamafafine na fai ma vakātua; o tamatane na fai ma ariki"—Daughters became priestesses; sons became chiefs.

and gave them the victory over their foes in other lands; his favour followed them on their numerous and hazardous voyages, and by that they were brought back in safety to their island home after many months' adventurous journeying.

So much we can still learn from the *talafua* (as they call their ancient songs) of this interesting people. Alas! there are but snatches of these ancient songs in the few legends that remain. These islands were depopulated by the Peruvian slavers in 1863. Almost all who would have handed on the ancient folk-lore of the race disappeared in that great calamity.*

II. The Ellice Group comprises Nukulaelae (or the Mitchell Group), Funāfuti (or Ellice Island), Vaitupu (or Tracey Island), Nukufetau (or De Peyster's Group), Nui (or Netherland Island), Niutao (or Speiden Island), Nanumanga or Nanomanga (Hudson Island), and Nanumea or Nanomea (St. Augustine Island).

I am unable in this paper to give notes of each of these eight islands or groups of islets. In most cases my time did not permit me to get reliable information as to the folk-lore of the island, if any distinct legends existed. Judging from results, I should conclude that the group is not so rich in ancient folk-songs as the Tokelau Islands.

Seven of these islands or groups are probably Samoan in origin, with an admixture of Tongese. In some cases the Tongan was introduced at a late stage, in others the Tongan element was almost contemporaneous with the Samoan, but in all cases the Samoan preponderates so much as to have controlled the language. As far as I am able to judge from a comparison of the most familiar words, the Tokelau and the Ellice Island dialects have become practically assimilated to each other. Samoan largely prevails in the whole of the Tokelau and the Ellice Islands; it is the literary language, except in the Gilbert or Kingsmill Island colony of Nui, where the Gilbert Island dialect is spoken with a small admixture of Samoan or Ellice Island words and constructions. Even in Nui the Gilbert Island dialect is gradually giving place to the Samoan or Ellice Island dialect, which is spoken by the Nanomangans who have hereditary rights on a portion of the land of Nui.

I visited Nui the second time after an interval of nine years, and I found that the Samoan language was much more widely understood than on my former visit. The young people are becoming so familiar with Samoan that divine service in that language is now frequently held on Sunday afternoon.

As is well known, there is excellent anchorage at two of the islands in the Ellice Group—namely, at Funāfuti and at Nukufetau. At both these places there is water.

Funāfuti is a group of some thirty islets surrounding a lagoon twelve miles in length. The people are descended from Samoans, known to posterity as Lafai, Le Fe'e (cuttlefish), Sa Sevē (the clan of Seve), and two others—five clans in all. They appear to have had more elaborate religious rites than other islands in the group. The group of atolls seems to have been filled with sacred places and

* From Fakaofo 247 men, women, and children were kidnapped, of whom only one returned, to die of consumption shortly after his return.

shrines. A temple with a covering was known as a "Fale-Atua," a shrine was an "Afu," and the priest, as in the Tokelaus and in Samoa, was a "Vakātua." Long after the significance of the temple was forgotten the stone shrine or memorial was worshipped.

The names of many of the islets in this group were given me. Not only here but all through the Ellice Group I found that not merely did every little atoll bear a name, but that the names of atolls and of known spots on these atolls were significant of some fact in its history, either original ownership or some physical feature of the islet, or some historical fact connected with the place.

The following names of islets in the Funāfuti Group are interesting:—Te Pava (the name of a Samoan, Upolu, war god); Te fua te fe'e, the offspring of the *Fe'e* (either the ancestor or the god incarnate in the cuttlefish), Aumatupu; Te muri te fala, the end of the pandanus; Te afu alii, the sweat of the chief; Te puka, the name of a tree; Te puka savilivili; Te fua lopa; Te fua fatu; Fuage'a; Te fala, the pandanus; Te fala o Ingo; Tutanga; Te ngasu; Te afua fou, the new beginning;* Avalau (this islet is said to possess a spring of fresh water); Motu ninie, ironwood islands; Nuku savalivali, the place where people can walk about; Motu loa, long island; Motu sa Nafa, the island of the Nafa clan; Te rērē; Te fata, the platform; Funāfala, the pandanus of Funa, the name of a chief, after whom also the group has been named Funāfuti.

Nukufetau is the name of a very beautiful group of thirty-seven islets almost surrounding a lagoon. The name signifies the land of the *fetau* (*Calophyllum inophyllum*), the only indigenous tree of large size found there.

The settlement is located on the island of Te anamu, and there are houses also on Sakuru. Fairly good water can be obtained on Te anamu. Other islets in this group are Te afuavea, Te afuana, Te afātule, Paifa, Funata, Mata Nukulaelae (like Nukulaelae), Teafualoi, Nuālei, Niuatangi, Teafuanono, Motu tu lua, Teafuniua, Niuatui, Niuatibū (a Gilbert Island language name), Oua, Lafaga, (where there is said to be fresh water), Niuarūko, Faiava, Potiki, Motu-raro (here also water is to be found), Motu-fetau, Motuloa, Te afua, Te motumua (here also there is water), Te afualoto, Motuloto, Te afua fale niu, Te afuatakalau, Te fale (here also there is said to be water).

The names here given will, to those acquainted with Gibert Island, Tongan, Samoan, and Rarotongan dialects, furnish instances of the influence of all these dialects in the nomenclature of the group. These names, the appearance of the people, and their traditions point to Samoa as the principal source of their origin.

A full and explicit account is given here of a Tongan invasion. Unfortunately I could get no clue as to the probable date of that invasion and the war which ensued. Two large war canoes were sighted, and with one of them, the warrior of Nukufetau, named

* The name refers to an unfortunate incident in connection with their first contact with the white man and their first knowledge of the deadly firearms of the foreigner. A vessel called at the mouth of the lagoon, and the natives were allowed on board. On leaving one of them stole a bucket. The canoe containing the thief was pursued, and, to the astonishment and dismay of the company, the man in pursuit was able to produce lightning and thunder and to inflict death.

Laupapa (evidently a Samoan name), was speedily in contact. After a parley a battle took place in which two Tongan "chiefs" named Savea and Tinaimanu were engaged. Tinaimanu is referred to as the breeder of wars in the "Eight Islands"—*i.e.*, the Ellice Group.

The Tongans were driven off, and went to Funāfuti. There one of the Tongan chiefs (it is not clear whether this was Tinaimanu or not) established himself; but Savea and his people returned to Tonga. The chief who remained at Funāfuti very quickly acquired a reputation for savagery. He practised cannibalism to such an extent that very shortly there were none but women and children left. Ten young boys, who were attached to the chief as his servants, when they grew up, formed a plot to murder the cannibal, which they successfully accomplished, thus ridding the Eight Islands of a scourge.

Amongst the traditional customs of Nukufetau one merits special mention. On Nukufetau, as elsewhere, infanticide or foeticide was the law of the land. Only one—some say two—were allowed to live in each family; the rest were strangled. But it was possible for the parents to ransom their offspring by giving a present to the chiefs, of whom at one time there were said to be forty. This ransom consisted of *seven* large bowls of *fausi* (scraped taro prepared with the juice of the cocoanut). So far as I know this is the only instance of the number *seven* being considered the number of completeness, as in the Hebrew Scriptures. Incidentally, the tradition bears testimony to the early introduction of the taro (*Arum esculentum*) into the group, in all probability from Samoa.

In those times stealing was the only other crime to which a penalty was attached. The penalty in that case is alleged to have been death. The only other island in this group which it is possible in the limits of this paper to notice is the interesting island of—

Vaitupu.—This is a small island, nearly round, with a salt lagoon in the centre. The people trace their ancestry to Samoa.

Their traditions very distinctly point to a direct connection with Samoa. The legend declares that the first inhabitants of Vaitupu were a number of people who swam there. As the names of that first party have been preserved, one may safely conclude that they had some efficient mode of conveyance, and were people of some consequence in their own estimation. The names of the principal male members of that party: Tangaloa, Kulu, Te-Foilangi, Tuifenua, Laukite, Si'o, Tafakula, and Maumau. They considered themselves to be kings, and to have natural rights, not only on the island they had made their own, but on other islands of the group. They called the island Vaitupu, the water of kings.

Their rights were subsequently disputed with another claimant in the person of a chief named Telematua, who, also with a party of retainers, hailed from Samoa. By stratagem the latter succeeded in ousting the prior occupants of the soil, who were scattered amongst other islands, to which they betook themselves.

Such is the tradition, but the pregnant fact remains that several of the party became deified, and we have Kulu and Foilangi, Laukite and Tafakula appearing as gods of Vaitupu as well as of the islands of Nanomanga, to which they may subsequently have gone. Foilape, a former king of Funāfuti, is mentioned as one of the principal gods of Vaitupu. Funāfuti appears to have had bitter experience of despotic chieftains. Foilape was a man of enormous physical strength, and a fearful despot. He had to flee for his life to Vaitupu, where he was honoured as a god, after he had been murdered as a despot. Another of the principal gods of Vaitupu was Te Moloti, evidently in his lifetime a man of a similar character to Foilape, for he was said to have been branded on the cheek and then driven away from Samoa.

Circumcision (or an equivalent ceremony) was practised on Vaitupu, but probably not on any other islands in the Ellice Group.

III. Gilbert Islands.—The islands in the Kingsmill or Gilbert Group known to the writer are five in number, and are situated south of the equator. They have all been christianised by Samoan native missionaries, and are the only islands in the group which have received Christianity through the medium of Samoans. The writer has derived his information of native traditions and legends through Samoans. Due allowance will therefore be made for the inevitable bias in favour of the Samoan as distinct from the Ocean Island origin of the people inhabiting the five islands here referred to.*

The islands are Arorae or Hurd Island; Nikunau or Byron Island; Peru; Onoatoa or Francis Island; Tamana or Rotch Island.

Judging from the testimony of Samoans, these islands would appear to be rich in legends which testify to the fact that the Samoans were, as Bougainville called them in his time, "navigators." In this they have undoubtedly retrograded in the generations which have elapsed since the Gilbert Islands were peopled.

Of the "gods" mentioned as formerly worshipped in these islands I found several of Samoan origin.

The principal settlement on the Island of Onoatoa is named Buariki. Everywhere I (and others before me) have found that Tapuariki† was worshipped as chief among the gods of these islands south of the line. On Arorae the tradition referring to him says that he swam from Samoa to Peru on two logs of wood apparently the *puapua* (*Guettarda speciosa*) and the *tauanave* (*Cordia subcordata*) of Samoa. The myth declares that these two logs of wood united, and the result was the child Eiarepoto (core of a tree), who became the wife of Tapuariki and mother of Kaneloa and Ntinuea, by whom Peru was peopled; thence also came the people of Arorae, Onoatoa, Nikunau, Tamana, and Tapitauea. At Onoatoa the Samoan origin of the people through Peru is confirmed. There also Tapuariki was considered to be the chief of the gods. Tamana is said to be a piece of land broken off from Banaba or Ocean Island. At Arorae the people worshipped Tangaloa and Borata. Both these names are well known in Samoan and Ellice Island traditions, Borata being Folasa of Samoa.

* The late Rev. Thomas Powell, for forty years a missionary in Samoa, in some notes written in 1871, quoted this as the opinion of Commodore Wilkes, and refers to Wilkes' Narrative, U.S. Exploring Expedition, vol. v., page 82. I have been unable to see and to confirm the opinion there given.

† An ancient stone on which in olden times offerings of fish to Tapuariki, the demigod of Manu'a (the eastward islands of the Samoan Group), were placed, could a few years ago, and may perhaps still, be seen at Taū, the principal island of the little Manu'a Group.

At Peru I got an interesting legend which the Samoan who gave it to me recognised as the legend of "Tangaloa Su'e-fanua."* Briefly stated the legend thus runs:—

A couple reached Peru from Samoa named Tiitii and Talanga. Soon after arrival in Peru, Talanga bore a daughter named Vaituutuu, who became the wife of Tanga'i from heaven. Their son was Talo, who took for wife Tepao, from whom came Aitu-o-le-vao (spirit of the bush), whose wife, Lafoaiiña, bore a daughter named Tamālii. This girl quarrelled with her mother, and, having constructed a float of cocoanuts, went to the island of Tarawa. She there became the wife of the King of Tarawa, "Nui-o-Tarawa." Their son, Launiu, one day asked his mother whence she came, to which she replied, "From Peru." Whereupon the son built a canoe, known in tradition by the name of "The Iātolima," from *the five bars* connecting the outrigger with the body of the canoe. In this Launiu alone ventured southward in search of his mother's old home, taking with him his pet fowl, or fighting bird. On his voyage he encountered the canoe of Tangaloa, who had sailed with his daughter and a retinue from Samoa. Tangaloa's daughter, whose name was Tavale, had also with her a favourite *Moa*, "The Aloimanusā." After greetings and the usual questions as to their lands and destination, they were about to separate when Launiu's cock began to crow. On this Tangaloa suggested a cockfight on the deck of the canoe. This took place, and the Samoan bird was victorious. Launiu immediately conceived the wish to become possessor of the Aloimanusā. Having preferred his request, Tavale had a good look at the son of the King of Tarawa, and, finding that he was very good-looking, decided not only to bestow her bird but her own hand to Launiu. She therefore suggested that her father, Tangaloa, should return to Samoa, whilst she accompanied Launiu. The destination of the latter was determined by the flight of the bird, who took the couple to Tapitauea, where the various names bear testimony to the story.

At Tamana and at Peru amongst the names of gods bearing Gilbert Island names was one Nareau. A legend of this mythical hero is preserved at Peru. It is peculiarly rich in local allusions, and confirms the universal tradition of the frequent voyages of the Samoans to these islands and to Tarawa, north of the equator. Nareau is announced in the introductory portion of the legend as the Creator of the heaven and the earth; and that he performed this enormous task whilst still in his Samoan home with his daughter Kobine. This daughter was invisible, residing in the caverns beneath the ocean. Before Nareau left Samoa he lived to see his descendants to the seventeenth generation. He went to Tarawa, and there his descendants numbered seventy-seven generations before his return to Samoa under the name he had acquired in Tarawa of "Tautebū."

On Nikunau and on Peru there are in each settlement enormous and very unique structures known as council-houses. The house at Nuka, the principal settlement on Peru, was formerly called Samoa, and was originally built with timber (*Te kai te biti*) called ironwood, which is traditionally said to have come from Samoa. The legend describing the building of this house ascribes miraculous properties to

* "Tangaloa," discoverer or searcher of lands.

the timber. It was first stranded at the settlement at the extreme west of Peru; but as it was unsuitable for the house which had been erected there, it could not even be dragged ashore. An attempt to appropriate the timber for the council-house at the adjoining settlement met with similar results; but at Nuka, at the house "Tabu n te biki," subsequently called Samoa, the timber proved its right to remain, not only by the ease with which it was dragged ashore, but by its suitability and adaptability to become the central pillar of the house.

Tanenitoa, "the harsh king," of Peru, held authority over the house. He was descended from Te mata warebe and Teimone, who came originally from Samoa.

In this connection one meets with the generally known legend of the mythical tree that was burnt by Kourabi in Samoa. The tree itself was named "Te kai n tiku aba" (the tree that should be distributed over the lands). Its root was "Te mata warebe"; the top of the tree was called "Te tāke"; the main root stem was called "Taubākoa"; and the fibres of the root were "Teimone," otherwise known as *Sa-le-fe'e* in Samoa. These were Samoans, but the others were people of Peru.

Such are the legends which abound in those islands to prove the fact, for which evidence is constantly forthcoming, that there was a time in the remote past when the South Sea Islanders generally were in much more constant and vital contact than they have been known to be in historical times, and when their skill in navigation and their knowledge of the sea was much more extensive and accurate than any race of Polynesians can boast of now.

The Gilbert Island traditions prove beyond a doubt that in the islands under notice the Samoan element has been strong enough to secure a place in the traditional folk-lore of the race. Their language contains abundant traces of this Samoan influence. But the language and customs of the people of these islands are not Samoan. These will be best approached and competently explained only by one from the northern islands of the group.

4.—EARLY SAMOAN VOYAGES AND SETTLEMENTS.

By Rev. JOHN B. STAIR, St. Arnaud, Victoria.

The traditions I have given elsewhere refer directly to the early settlement of the Samoan Group; another, and of a widely different character, will now be considered, showing how, as from a centre, voyages were made from Samoa to other distant groups and over a vast extent of ocean. The records, of which I give a summary, were written for me in 1842, and they describe not only the first settlement of Rarotonga by Samoans, but long-continued and extensive voyages undertaken by successive generations of Samoans, extending over many years and covering a vast extent of ocean. The record purposes to be "The history of the peopling of Rarotonga, with the generation of the people of Samoa, whence they sprang."

The record commences by stating that Tangaloa, or, as he is also called, Tupua, was the first chief of Upolu. It then proceeds to give a connected list of seventy-three names of chiefs or rulers, the last of which is Tangiia, one of the two famous voyagers who first settled one portion of Rarotonga. This list of powerful chiefs, who governed on Upolu or other parts of Samoa, is most interesting and suggestive. In it I find the names of chiefs who held sway on Savai'i, as well as those who were supreme on Upolu: Rata, with Atonga, Iro, and Karika, were chiefs of Savai'i, whilst Tangaloa, Tealutanga-nuku, and his successors and others were chiefs of Upolu, who, in a series of years, made long and distant voyages to all parts of the compass; Tahiti, Marquesas, Futuna, Uvea (Wallis Island), Fiji, Tonga, Rarotonga, and many other islands being in turn visited more than once in some cases, and also in part colonised, from Samoa by those enterprising leaders.

The first canoe spoken of, a *vaatele* (great canoe), was built on Savai'i, in a forest belonging to Rata, by Atonga and his two brothers, Olokeu and Oloinano. After the canoe was built it became the property of Tealutanga-nuku, lord of Aana, Upolu, who first sailed in her.

First Voyage of the Canoe, "Tealutanga-nuku," to the South-south-west and West of Samoa.

The canoe visited all the lands in that side of the heaven, but did not go to the upper side of the heaven, or towards Tahiti; and when the year was finished the chief gave the canoe to his son, Tealutanga-langi, who made the second voyage.

Second Voyage, under Tealutanga-langi, to Fiji, &c.

At this time the name of the canoe was changed to "O le folauloa-i-Fiti" (the voyage direct to Fiji), because the canoe went direct to Fiji, but did not go to the eastward. At the close of that year the chief gave the canoe to his son, Kaukula.

Third Voyage, under Kaukula, to Fiji and Tongaleva.

Kaukula visited Fiji and the lands his father had visited. He also visited another land, which was then known for the first time, called Tongaleva. After this he returned to Upolu, and gave the canoe to his son Malu, who again changed the name of the canoe to "Numia-au" (confusion of currents).

Fourth Voyage, under Malu.

Malu now voyaged towards the upper side of the heavens—*i.e.*, east or north-east—whither he went with his father, Kaukula. They discovered a small island named Tokutea, where Malu left his father, and then sailed about with himself only and his men, and afterwards returned to Samoa.

Fifth Voyage, by the Family of Malu, to the South-south-west and West.

Some of the family of Malu sailed to the lower part of the heaven (south-south-west and west), and these are the lands they visited: Tonga, Fiti, Nuku, Ololilo, Nu'u, Angaula, Kulupongi, Alama ti'eti'e, Matatela, Vaeloa, Takinuku, Uvea, Amama, Tuma (Rotumah), with all the islands visited by the family of Malu. At the island of

Nu'u they built a canoe for the chief, who named it "O le va'a-tapalangi" (canoe beckoning the heavens). On this account they proclaimed Tangiia to the chieftainship, and his father also gave him his title. He also obtained three idols—one from Nu'u, called "Kotilongo-Mana"; another from Amama, called "Malu-mao-mao"; and the third, called "Tonga-iti." These were the idols which he and his family worshipped.

Sixth Voyage—Tangiia, who sailed to the East and settled at Tahiti.

After this they left that side of the heavens, and sailed east to Niue (Savage Island) and Niutaputapu (Keppel's Island), with Niulii, Niutala, and Iva (Marquesas); and then sailed for Tahiti, where Tangiia made a settlement at a place called Punaauia. This was a settlement of the three classes of people who were called the diminutives. It is said they were so short that they could not be seen when they walked in the high grass or undergrowth—"E le iloa fo'i pe'ā savali i mea vaoa." Whilst at Tahiti, Tangiia married a woman named Aleinaia, the daughter of Maono, by whom he had three children, and then discarded her. At Tahiti war broke out between Maono and Tutapu, of Marquesas, who defeated Maono. At Tahiti, also, Tangiia's sister was married, on which Tangiia gave her his big canoe—the one brought by the birds—in which they sailed for Huahine.

Seventh Voyage—Tutapu.

The Marquesan chief, Tutapu, sailed for Rarotonga, and on reaching there he and his party set to work to drain the swamps of the island, and settled at the side of the island where the Rev. Aaron Buzacott afterwards lived. Here they made a great mound, and called it Ivatele, after the name of their land.

Eighth Voyage—Iro and Company.

When Tutapu and his company reached Rarotonga they found that another company of settlers had preceded them—Iro and his company, from Samoa, having reached there and settled on another part of the island. After remaining some time at Rarotonga, Iro sailed for Tahiti.

Ninth Voyage—Tangiia to Rapa.

Tangiia sailed for Rapa, and on reaching there he found that Iro had also gone there, after he left Rarotonga. They remained there together some time, and then returned in company to Tahiti.

Tenth Voyage—To Mauke (Tangiia).

Tangiia sailed for Mauke, to see the daughter of Auli, chief of Mauke. After some time he returned to Tahiti.

Eleventh Voyage—Iro sails for Samoa.

Before sailing he gave one of his sons to Tangiia to adopt—"that Tahiti might not be without a king" in case of his death, and that the pigmies, or four classes of "little people," might still have a chief. Tangiia named his adopted son "Te ariki upoko tini" (chief of the thousands of heads). He was also called chief of the four classes of little men. A long description is also given of the war between

Tutapu and Tangiia. In despair, Tangiia appeals to the sister, who gives back to him the old canoe, on which its name was changed to "O le tika o le tuafafine" (saved by the sister); and Tangiia, by advice of his counsellors, returned to Samoa.

Twelfth Voyage—Tangiia, South.

After a time Tangiia and his party started on another voyage, sailing south. They visited Nu'u, Angaula, Alamati'eti'e, Matatela, and Uvea, five islands which had before been visited in the fifth voyage by the family of Malu many years before. From Uvea (Wallis Island) they sailed to Takinuku, where they dwelt for a time. From thence they sailed to Rurutu and Papau, also called Rimatara, and remained there for a time. Again they sailed *i lunga* (*i.e.*, north or north-east) to an island named Maketu, where they first met with another navigator named Karika, a chief from Iva (or Marquesas).

The Meeting of Tangiia and Karika.—Karika's canoe was hostile, and Tangiia prepared for battle. Karika's canoe was a pirate canoe, *a vaa fasi folau*, and a battle seemed imminent; but the pirate, seeing the other was the larger canoe, having 200 men as against the pirate's 70, swam on board with his daughter, and submitted to Tangiia. The pirate chief Karika then presented his daughter to Tangiia as his wife. Her name was Mo-oloa-i-aitu. Tangiia then took off his own crown, or *pale ula* (red coronet), and presented it to Karika, saying, "I hereby adopt you." He did so because he had given him his daughter and because he hoped to secure his help in his proposed attack upon his old enemy Tutapu. The two canoes then sailed in company, but afterwards separated, as Tangiia found that Karika was endeavouring to entrap him by leading him a course that would engulf him in the *fafa*, a submarine disturbance, in the outskirts of which Tangiia was entangled. Observing signs of the whirlpool, and feeling the water hot, he at once put his canoe about, and so escaped the danger. He then parted company with Karika, and sailed for Rarotonga, which island he reached safely, and landed at a place called O le vai Kokopu, where he anchored, and determined to settle there.

The history then proceeds to detail the steps taken by the immigrants to establish themselves on that part of the island, and describes how, on going to the other side of the island, they found that Karika's company had preceded them, and were preparing to settle there. The parties embraced and fraternised. After this Tangiia returned to the other side of the island with his company to complete arrangements for settling there, when in the midst of all their busy preparations they were astonished to see the canoe of the much-dreaded Tutapu sail into the harbour, and cast anchor near to Tangiia's vessel.

The narrative continues to describe other interesting details of the after proceedings of the colonists, and their subsequent adventures, but which are too long to be given here, that which has already been given having also of necessity been much curtailed. The writer of the narrative concludes as follows:—

I now finish this history of the growth of the people of Rarotonga from Samoa. The Samoans say we are of a different race, but they do not understand; we are sprung from Samoa, and we are their brethren.

Another example of early Samoan settlement may be given :—

A banished Tui-A'ana (Lord of A'ana) becomes a settler in Rarotonga.

In Samoa, the *Tulafale* (the ground or foundation on which the house is built) are a very powerful class, similar to the Rangitira of New Zealand, the real authority and control of districts being frequently centred in them. They are the principal advisers of the chiefs. The orators are usually from their class, whilst the *ao* or titles of the district are always in their gift; and they have the power —which at times they do not scruple to use—of deposing and banishing an obnoxious chief Hence there have been many instances in which this class, combined with the *Fale Upolu* of the district, have banished their chiefs on account of their tyranny and oppression. On such occasions the obnoxious chief was always taken to Tutuila, the recognised place of banishment, and committed to the charge of the authorities of the island. Intelligence of such an event being about to take place was always forwarded to the chiefs and people of Tutuila, who prepared for the arrival of the banished chieftain and his party. This was always a large one, as a great many of the chiefs and people of the district accompanied the exile to see that their sentence of deprivation and also of punishment and degradation was duly carried out. After the visiting party had met the Tutuila authorities, and duly informed them of their having brought their chief to commit to their keeping, the prisoner was landed from his canoe and made to run the gauntlet from the beach to the settlement, the inhabitants of the district forming two lines between which the captive ran, whilst he was beaten with sticks, pelted with stones, and subjected to other indignities until he reached the settlement. It was a fortunate thing for him if he escaped with only bruises, since at times severe injuries were inflicted, and even life sacrificed.

Tradition tells of a chief of Savai'i being thus banished; as also of a *Tui-A'ana* (Lord of A'ana) having been deposed and banished by his district, some very interesting and far-reaching circumstances being connected with the banishment of the latter. The party conducting him reached Tutuila in the evening, and his formal landing was deferred until the morning. During the night the captive chief signified to some of his attendants his unwillingness to submit to the indignities about to be offered him, and at the same time stated his wish to commit himself to the wide waste of waters in hope of finding a refuge in some distant island, or perish in the attempt. He succeeded in enlisting the sympathy of his companions, and, taking advantage of a westerly wind that was blowing, they cast off their frail vessel from her moorings and silently glided away from the islands. Singular to relate, after enduring great hardships and privation, they reached Rarotonga, an island 800 miles distant from whence they started. As they neared the island they were distressed with apprehensions as to the reception they were likely to meet with from the people of the unknown land. They were, however, soon relieved on that head, since they were kindly received and conducted to the chief of that part of the island, who welcomed them, and allotted them a district in which to dwell. As they became able to hold more complete intercourse with the people of Rarotonga, they were much astonished to find that this island to which they had drifted had been mostly peopled many generations before by colonies from Samoa, their own countrymen. These had colonised Rarotonga under three adventurous leaders, Tangiia, of Upolu, Makea, of Manu'a, and Iro, of Savai'i. The descendants of these early Samoan colonists and voyagers treated their unexpected visitors with kindness and help, thus enabling them to settle comfortably in the land to which they had come; the newcomers naming a variety of places and objects in their allotted district after similar ones in A'ana, or Upolu, from whence they had come. Years rolled on, and at length a descendant of this banished chieftain and deposed Tui-Aana, named Malie, came to Samoa as a native teacher and evangelist, and especially charged by his family in Rarotonga to inquire into the particulars relative to the banishment of their ancestor. I had the pleasure of hearing from him the foregoing narrative, and of recording the details. I was interested in noticing the pleasure manifested by Malie on finding that there were places in A'ana, &c., corresponding to those he mentioned as having been named in Rarotonga by the banished chieftain and his party. At the time I met Malie, in 1842, I was visiting Palauli, on Savai'i, and had with me as travelling companions several A'ana chiefs and leading men of the district. The tradition of a *Tui-A'ana* having been deposed and banished was well remembered by them; but they knew nothing whatever of the fate of this particular banished chief and his party, who were commonly supposed to have been driven off the island during the night, and perished in the *Moana uli*, or the deep blue sea.

Trading and Fishing Voyages.

Apart from these long and difficult voyages which the Samoans were accustomed to make in the distant past, they also in bygone years made frequent voyages to groups around for trading or pleasure—Tonga, Fiji, Atafu (Duke of York's Island), and other lands to the north, north-east, and north-west being frequently visited; return visits being made to Samoa from these groups, especially from Tonga and Fiji. Of late years these trading voyages have ceased, apparently since a more settled and frequent intercourse with Europeans has arisen, and also since the disuse of the *vaatele*, or great canoe, which differed materially from the small double canoe, the *alia*, at times now used. This is indeed a copy of the Tonga double canoe. The *alia* is formed by lashing two canoes of nearly equal length together by stout crosspieces, which are securely fastened into the gunwales, and upon this stage in the centre of the canoe a thatched shed is placed for the accommodation of the crew. In the *vaatele*, or great canoe, one body of the canoe was much longer than the other, and instead of the shed being built in midships it was placed on a stage that projected far over the stern. It differed also in the rig, and was altogether more difficult to manage than the *alia*, which has superseded it. The last of these once famous canoes was in existence in Samoa when I reached there in 1838. It belonged to Pe'a, a chief of Manono, but was broken up some short time after I reached the islands, and I do not think another has been built since. These large canoes must have been of considerable size, since, upon the fishing expeditions made at certain seasons of the year to a reef midway between Wallis Island and Savai'i, they were accustomed to carry two *vaa-alo*, or large fishing canoes, on the deck, which, on reaching the reef, were used in fishing for bonito, &c., the large canoe being reserved for crew and cargo.

Arrangements for Voyages.

I have often asked the natives how they managed for cooking, storage of water, sleeping accommodation, &c., during their voyages. As to the former, provision was made for a fire by building up stones and earth in some part of the hold or shed, whilst water was stored in bamboos, or water-bottles made from gourds or cocoanuts. In answer to my query as to whether they did not often run short of water, they have astonished me by saying that the voyagers always took a supply of a certain kind of herb or shrub as a stand-by in case of need. By chewing the leaves of this plant, they declared that they could drink the sea-water with some kind of impunity, and thus assuage thirst. I made many ineffectual inquiries as to the name of this plant, but could never find out what it was. Those I asked said they did not know what the shrub was, but were confident that such a custom prevailed in the past, when voyages were more frequently made by their ancestors. Subsequently I have ascertained that cocaine has the power of so completely deadening the palate and throat that sea-water may be taken with impunity, so far as taste is concerned, but that the consequences of drinking sea-water for any length of time would be disastrous. The miners of some part of South America chew the leaves of the coca-plum mixed with lime, and find in it a great resource and consolation, as it is said to remove the sense of hunger and thirst, and enables them to endure fatigue. The kola plant and nut also possess similar properties, and have been known before the earliest written records, for they enabled the natives to perform journeys the reports of which at that time seemed incredible, and, in fact, they were called, "travellers' tales"; but later information has proved their value. I think it likely that some plant of the coca species may be found in Samoa, or some neighbouring group, that at one time supplied the wants of these early voyagers. The Rev. S. Ella tells me that he had never heard of the plant I speak of being chewed by voyagers, thus allowing them to drink sea-water as safe and palatable: "I have known, experimentally, that chewing the Ti leaf (*Dracæna*) allayed the feeling of thirst." Further research may show that some such plant as the coca shrub was known to the Samoans in the early times, and used by them as an adjunct in their voyages.

Fish would be often procured as they sailed onwards, and which it is probable would be eaten raw in many cases, as is the custom with numbers in the present day, *I'a otaā*, or raw fish, being esteemed a great delicacy. Stores of fruit, and prepared or fermented bread-fruit, *Masi*, would also be taken on board, and replenished from time to time, as also water, at the different islands they visited; and in many instances these calling-places were not only well known but of frequent occurrence. The sleeping accommodation must have been scant and uncomfortable, but the Samoans were not so particular in these matters as we are, and by dividing their crews into watches they would generally manage to get some rest.

Certain constellations were their guides in sailing, to which they trusted with confidence and success; the *Amonga*, Orion's belt, being the usual guide to those visiting the Friendly Islands. In many cases they were accustomed to take their idols, or *teraphim*, on board as a protection and shield. In several instances, in the old traditions, the names of the idols taken on board are recorded, and at times even fresh ones obtained at islands which were visited.

5.—OUTLINES OF A GRAMMAR OF THE "YAGGARA," THE LANGUAGE OF THE YERONGPAN TRIBE ON THE "SANDY COUNTRY" BETWEEN BRISBANE AND IPSWICH.

By JOSEPH LAUTERER, M.D.

The languages of the Australian continent are divided, according to Max Mueller, into four groups, altogether different from each other, and in the same way different from any other language on earth:—

1. The North Australian group is very little known.
2. The West Australian languages have been known since the times of Governor Grey, who spoke and described the language on the Swan River, and near King George's Sound.
3. The Parnkalla languages on the Murray River and on Encounter Bay have been investigated by the German missionaries Schürmann and Terchelmann (Murray), and by the German missionary Meyer (Encounter Bay).
4. The languages of East Australia—the Kamilaroi, Wirataroi, Pikumpul, and Tipil language—have been studied by Threlkeld, who wrote a grammar of a tribe between Sydney and Moreton Bay, which is reproduced by Max Mueller in the books of the Austrian Novara Expedition. Ridley gives the outlines of the Turrabul language spoken in different dialects through the whole Moreton Bay district.

The Yaggara dialect, spoken in the "sandy country" (Yerongpan) between Brisbane and Ipswich, differs in many respects from the true Turrabul as it occurs in Ridley's grammar. Its chief characteristics are as follow:—There are the vowels *a*, *e*, *i*, *o*, *u*, *æ*, *œ*, besides the *y* (as in yes); and twelve consonants—*k*, *n*, *n'*, *d*, *t*, *b*, *p*, *m*, *w*, *r*, *l*, *s'**. The accent is mostly on the penultimate. There is no gender or number properly, these being formed by agglutination of other words. The verb is a noun; its forms originate through agglutination and the addition of suffixes. The vowels are pronounced as follows:—*A* as in father, *e* as in ten, *i* as in kiss, *o* as in go, *u* as in true, *æ* as *a* in happy, *œ* as *u* in but. Of the consonants *n'* and *s'* have a sound not easily pronounced by an English tongue, being identical with the Slavonian *n* and *s* before *i*.† The noun in the Yerongpan language has only one form for the singular and one for the plural, this latter being formed by putting ds'in (many), or ds'angil (plenty), or pas'agon (more than one) behind the word.

Yerongpan.	English.	Yerongpan.	English.
Bing	Father	Mara	Hand and finger
Bingds'in, or bingds'angil, or bingpas'agon	Fathers	Tsitne	Foot
		Kabui	Hair

* ts' is by English authors given in a clumsy way by the English consonant j.
† The English *s* is utterly unknown in the Yaggara language

Bus'ang	Mother
Bus'angds'in	Mothers
Yuramkan	Baby girl
Mulam	Baby boy
Pusiri	Boy
Gin	Little girl
Ds'undal	Big girl or woman
Walinggara	Old woman
Goeranam	Black man
Doeger	White man
Karapi	White man
Bos'ae	Old man
Womugiri	Brother
Ds'as'in	Sister
Ds'alo	Fire
Dsalugnae	Light
Ts'umo	Smoke
Dabil	Water
Waril	Stream
Ts'arra	Earth
Buran	Air or wind
Burugara	Sea
Guma	Rain
Teraba	Hail
Maral	Lightning
Mugara	Thunder
Noen'gagan	Summer
Yigilgan	Winter
Nguno	Night
Yaragal	Evening
Gilen	Moon
Bigi	Sun
Mirigin	Star
Yabma	Arm
Yeren	Beard
Dandara	Breast
Wowul	Chin
Binne	Ear
Mil	Eye
Gutnti	Elbow
Gaudn	Blood
Tsiribetn	Bone
Mumkul	Fist

Magul	Head
Dugul	Heart
Bunn	Knee
Goedna	Liver
Toemburu	Lip
Buguru	Lung
Murru	Nose
Guta	Rib
Ts'urugung	Tongue
Baguru	Tree
Dumbam	Staghorn fern
Ds'enkalkal	Water lily (*Crinum pedunculatum*)
Deregen	Nest fern (*Asplenium nidus*)
Burumyaba	Tree fern
Nuta	Fig-tree
Ts'unbul	*Araucaria*
Billin	Parrot
Geyera	Cockatoo
Guranam	Kangaroo
Bara	Female kangaroo
Giriwon	Small kangaroo
Garil	Wallaby
Kupi	Opossum
Meyi	Dog
Ngalgal	Dingo
Binkin	Turtle
Bundsim	Native cat
Guralbang	Brown snake
Mundulkun	Death adder
Burin	Wasp
Kuts'æ	Honey
Kobae	Smallest bee
Tsalumban	Black bee
Ts'unbara	Fly
Gulalung	Ant
Giwerong	White ant
Bingking	Beetle

Many words are taken from the English in a mutilated form, *e.g.*—

Buredn, bread
Tseruse, trousers
Waimerigen (white Mary), an English lady
Bullae, ox
Dimer, steamer.

Many other words have evidently been received from the German as it is spoken by the Low German farmers—*e.g.*, ya wul, yes, yes (*ja wohl*); adyoe, good bye (*adieu*). Some words have only been invented since the white men came in contact with the aboriginals—*e.g.*, the horse (yerenam) is named after the kangaroo (guranam), exactly in the same way as, according to Governor Grey, the horse is named after the kangaroo in the West Australian dialects, and as, according to William Thomas, the cow is named kurumn, after the kangaroo (kuru).

The names of native weapons as adopted by the colonists are mostly derived from the Sydney blacks. The boomerang, for instance, is called baragan, or bargan, in the Yerongpan language. Only a few colonial English words, and some names of localities round Brisbane, are derived from the Yaggara language—*e.g.*, a rough wooden house is called a "humpy," from the Yerongpan word ngpi, house or camp; Humpybong means a dead camp (not houses of the dead); Tingalpa means land of the fat (kangaroo); Yeronga means sandy (Yeerongpilly is a queer corruption adopted by the Railway Department for a station behind Yeronga).

The adjective is, as in the English language, unchangeable; it has no gender, no number, no case—

Marumba, good	Niewang, beautiful
Marumba goeranam, a good man	Buel, tall
Marumba goeranamds'in, or marumba goeranampas'agon, good men	Ts'algal, small
	Gurun, black
	Giwere, white
Goeranam marumba, the black man is good	Nangka, hot
	Yigil, cold
Wadli, bad	Bandara, strong
Wadli womugiri, the bad brother	Manmal, weak
Wadli womugirids'in, the bad brothers	Bayi, ill
	Tinggal, fat
Niua, nice	Mugan, fat.

The comparative does not differ from the positive form of the adjective. It is marked only by the word ngi, "than," which follows —*e.g.*, marumbangats'a, I am good; marumbangats'a ngi nginte, I am good than you—*i.e.*, I am better than you. The superlative is given through a repetition of the positive—*e.g.*, marumba-marumba, very good; wadli-wadli, very bad; kawae-kawae, very sweet.

There are few numerals in the Yerongpan language. The aboriginals lived in the golden age when no money was invented, and no mathematics had to be used to mark the distinction between mine and thine. The sea blacks can count up to 5. The Yerongpan tribe has a special word only for 1 and 2—

Coast Tribes.	Yerongpan.
1—Wakol	Kanyara
2—Puloara	Bullae
3—Noro	Bullae-kanyara (2 plus 1)
4—Waran	Darawa-darawa (as much, as much)
5—Kawul kawul (much-much).	Bullae nga bullae kanyara (2 plus 2 plus 1).

What is over 5 is ds'angil, plenty. Menyembu kupi putninginte? How many opossums have you killed? Bullae nga bullae kanyara, five.

The pronouns are :—

1. Personal pronouns :

Ngats'a, I	Ngalam ds'undal, she
Nginte, thou or you (male)	Ngadli, we
Ngilpula, thou or you (female)	Ngilpula, you
Ngalam, he	Layim, they.

2. The possessive pronoun is formed from the personal pronoun by affixing "nganowa" to it :

Ngats'anganowa, my	Ngilpulanganowa, your
Ngintenganowa, your (male owner)	Layimnganowa, their
Ngilpulanganowa, your (female)	Ngadlinganowa bing, our father
Ngalamnganowa, his	Ngadlinganowa bingds'in, our fathers
Ngalam ds'undal nganowa, her	Ngilpulanganowa wallinggara-ds'angil, our old women.
Ngadlinganowa, our	

The verb "to be" in the Yaggara language of the Yerongpan tribe is very simple. "I am" is given through "I." "I was" is expressed by putting "banyi" between the adjective and the pronoun—

Present.	Preterite.
Marumbangats'a, I good (I am good)	Marumbabanyingats'a, I was good
Marumbanginte, you (boy) are good	Marumbabanyinginte, thou (boy) wast good
Marumbangilpula, you (girl) are good	Marumbabanyingilpula, thou (girl) wast good
Marumbangalam, he is good	Marumbabanyingadli, we were good
Marumbangalam ds'undal, she is good	Marumbabanyinginte, you were good
Marumbangadli, we are good	Marumbabanyilayim, they were good.
Marumbangalam, you are good	
Marumbalayim, they are good.	

The future tense is seldom employed, the present being taken for it. The mind of the aboriginal was much too careless to think of a future time, and too bright to think of coming good or evil. The future, if used, is transcribed by "baru," soon—

Future.

Baru marumbangats'a, I shall be good
Baru marumbanginte, thou (boy) wilt be good
Baru marumbangilpula, thou (girl) wilt be good
Baru marumbangalam, he will be good
Baru marumbangalam ds'undal, she will be good
Baru marumbangadli, we shall be good
Baru marumbangilpula, you will be good
Baru marumbalayim, they will be good.

The other verbs have two active forms, one for the present and future, and another one for the preterite—

To come :	To go :
Future and Present—	*Future and Present*—
Balkana	Yadmanya
Preterite—	*Preterite*—
Balkari	Yadni

Present—
Ngats'a balkana, I come
Nginte balkana, thou comest (boy)
Ngilpula balkana, thou comest (girl)
Ngalam balkana, he comes
Ngalam ds'undal balkana, she comes
Ngadli balkana, we come
Ngilpula balkana, you come
Layim balkana, they come

Future—
Baru ngats'a balkana, I shall come
Baru nginte balkana, thou (boy) wilt come
Baru ngilpula balkana, thou (girl) wilt come
Baru ngalam balkana, he will come
Baru ngalam ds'undal balkana, she will come
Baru ngadli balkana, we shall come
Baru ngilpula balkana, you will come
Baru layim balkana, they will come

Preterite—
Ngats'a balkari, I came
Nginte balkari, thou (boy) camest
Ngilpula balkari, thou (girl) camest
Ngalam balkari, he came
Ngalam ds'undal balkari, she came
Ngadli balkari, we came
Ngilpula balkari, you came
Layim balkari, they came.

Present—
Ngats'a yadmanya, I go
Nginte yadmanya, thou (boy) goest
Ngilpula yadmanya, thou (girl) goest
Ngalam yadmanya, he goes
Ngalam ds'undal yadmanya, she goes
Ngadli yadmanya, we go
Ngilpula yadmanya, you go
Layim yadmanya, they go

Future—
Baru ngats'a yadmanya, I shall go
Baru nginte yadmanya, thou (boy) wilt go
Baru ngilpula yadmanya, thou (girl) wilt come
Baru ngalam yadmanya, he will go
Baru ngalam ds'undal yadmanya, she will come
Baru ngadli yadmanya, we shall go
Baru ngilpula yadmanya, you will go
Baru layim yadmanya, they will go

Perfect—
Ngats'a yadni, I have gone
Nginte yadni, thou (boy) hast gone
Ngilpula yadni, thou (girl) hast gone
Ngalam yadni, he has gone
Ngalam ds'undal yadni, she has gone
Ngadli yadni, we have gone
Ngilpula yadni, you have gone
Layim yadni, they have gone

Imperative—
Yadman, go!

The transitive verbs have no passive form; it is supplied by the active.

The negative of the verbs is formed by putting yaggara (not) at the beginning of the sentence—*e.g.*, Yaggara ngats'a yadmanya, I don't go. In the interrogative form the syllable *ngi* (corresponding to the Polish *czy* or *czyly*, or the Russian *ly*) is inserted between the verb or adjective or pronoun—

Yadmanya ngi nginte, dost thou come?
Bayi ngi ngalam ds'undal, is she sick?
Wuaera ngi nginte, are you hungry?
Wadlingi nginte, are you bad?
Wuaera ngi ngalam ds'undal, is she hungry?

Of course sentences like this are not very often used in the rapid conversation of the Yerongpan tribe; still, from a grammatical point of view, they are quite correct, and easily understood by anybody who has got more than a superficial knowledge of the language.

Particles of the Yaggara language of the Yerongpan tribe are—

Nga, and
Beren, to-day
Ngubuga, to-morrow
Ugunúara, yesterday
Baru, by-and-by
Wunyango, whereto
Ngan, who
Wunya, where
Wunyango yadnanya ngi nginte, where do you go?
Ngan nginte, who are you?

If two aboriginals of the Yerongpan tribe meet, they say, "We balka," come here! (welcome!). In parting they say now, "Go wa," perhaps altered from "go away!" They believe in a kind of bugbear who kills and eats the blackfellows. They do not call it Bunyip ("buni" means awful or holy), but Worrid's'am. Like the other tribes they are fond of dances, of music, and songs. Some of these have no sense at all, and seem to be derived from other tribes, *e.g.*—

'Yu darin mara, yu darin mara, yu darin manna wae!'

repeated some times. Another one:

"Yar limbinger, yar larmbinger, bi yarn duma, bi yarn duma, wae!"

Another one, where "mirrigen" means "star," and "baru" "soon," is:

"Mirrigen, merrigen, marn,
Mirrigen, merrigen, maru, baru, baru, baru!"

Other songs are short sentences in the Yaggara language, like—

"Mara yankuma ngangpo niewang manpawo, wae
Mara yankuma ngangpo niewang manpawo mara yankuma!"

"Keep the fingers stiff, dancing nicer always," &c. Another short song means, "Nice is a song with a white girl"—

"Gayalo ngarampa waimerigen nowago!"

Some of the personal names of the Yerongpan aboriginal seem to have no meaning. For instance, a name very often heard is Kalanggaba, for a man; Kalangga, for a woman. Tsarlumbankan is another female name often met with of which no meaning can be given.

The old "king of the Logan and Pimpama," Jackey-Jackey, is called by his tribe Kawae-Kawae (very sweet), because more than forty years ago he uttered this word when he tasted the first glass of rum.

The Yerongpan tribe's "drooping days are dwindling down to naught," as Thomson has it.

6.—ROCK PAINTINGS AND CARVINGS OF THE ABORIGINES OF NEW SOUTH WALES.

(WITH PLATES.)

By R. H. MATHEWS, L.S., and W. J. ENRIGHT, B.A.

INTRODUCTION.

My friend and fellow-worker, Mr. W. J. Enright, B.A., has requested me to make a few remarks in connection with his paper on some aboriginal rock paintings which he visited in the Wollombi district, New South Wales. I am much gratified to learn from him that I have been the means of introducing such an active and diligent worker into the comparatively unbroken field of this branch of anthropology.

I have been endeavouring for some time to copy and describe in detail* as many as possible of these specimens of pictorial art, showing the inventive and imitative faculties of a primitive people, and I hope that everyone who has opportunities of observing these drawings in different parts of Australia will make an effort to record them. This work should be done without delay, as these rock pictures are becoming fainter and less numerous every year by reason of the disintegration of the rock surfaces on which they are drawn. In several of the carvings found by me upon rocks, only parts of the figures could with difficulty be traced out; in others, the whole outline was faintly distinguishable; whilst others were clear and well defined. The same remarks will apply to the paintings. In the numerous caves visited by me some contained paintings which were quite distinct, whilst in others the figures were in various stages of decay—some being barely discernible owing to the wasting of the rock under atmospheric influences, and in a few instances I was told by old residents that in caves which they once knew to contain paintings nothing is now visible.

Early History.—Rock carvings were observed in the neighbourhood of Port Jackson, New South Wales, by Dr. J. White † on the 16th April, 1788, a few months after the colony was founded; and on the 14th January, 1803, Captain Matthew Flinders‡ discovered some rock paintings on Chasm Island, adjacent to the coast of the Gulf of Carpentaria. At intervals, very few and far between, from these dates to the present time fragmentary references have been made by explorers and others to these specimens of aboriginal art, but very little work of any practical value for ethnological purposes has been attempted until recently.

Geographical Range.—Rock paintings have been seen in West Australia at places far apart; they are found throughout South Australia from the southern portion to the Gulf of Carpentaria and Port Darwin. They are widely distributed over New South Wales, and in Queensland they are scattered from Cape York to the southern limits of the colony. In Victoria they are found on the western side of the Victoria Range, county of Dundas, and on the north-eastern side of the Grampians, in the county of Borung, and probably exist in other parts of that colony.

Rock carvings are neither so numerous nor have such a wide geographical range as the paintings, but they have been observed in all the colonies above named, with the exception of Victoria. I have instituted investigations in districts abounding in large masses of sandstone, which will, I hope, result in the discovery of native carvings in Victoria similar to those found in the other colonies.

Paintings, how Produced.—Aboriginal rock paintings are executed in three different ways, which I shall call, for the purpose of my description, (1) the stencil method; (2) the impression method; and (3) the outline method or ordinary drawing.

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* This is the sixth of a series of papers on Aboriginal Rock Pictures contributed by me to different societies, and which have been published in their journals.

† "Journal of a Voyage to New South Wales," p. 141.

‡ "Voyages to Terra Australis," vol. ii., pp. 188-9.

(1.) In stencilling figures of the human hand or other objects on the walls of caves, a smooth surface was selected. The palm of the hand was then placed firmly on the rock, with the fingers and thumb spread out, and the required colour, generally pipeclay, red ochre, or powdered charcoal, was squirted or blown over it out of the mouth. This method of drawing was also adopted in many instances in representing implements of the chase, such as boomerangs, tomahawks, waddies, &c.

(2.) In the impression method the colour to be used was mixed with water, or with oil obtained from fish or birds, in some kind of native vessel, into which the palm of the hand was lightly dipped, and then pressed against the surface of the rock. On the removal of the hand the coloured imprint of it was left clearly defined.

(3.) Objects to which neither of the preceding methods would be applicable were drawn in outline in the required colours. In some cases the objects were merely outlined, in other instances they were shown in solid colour all over, whilst in others the space within the margin of the outlines was shaded by strokes of the same colour or a different one. Judging by the appearance of the lines in several of the figures drawn by this method, I think it not unlikely that, before commencing the drawing, the surface of the rock was damped with water or moistened with animal oil, and that then a piece of the required colour, as a lump of red ochre, or pipeclay, or charcoal, was held in the hand of the operator, and the necessary lines drawn with it upon the rock.

For complete specimens of all the different kinds of painting practised by the aborigines, see Figs. 1 to 8, Plate II., annexed to my paper on "The Aboriginal Rock Pictures of Australia," published in the Proceedings of the Royal Geographical Society of Australasia, Queensland Branch, vol. x., pp. 46-70.

Carvings, how Produced.—Two methods appear to have been used by the natives in producing rock carvings: (1.) That most generally adopted was to cut the required figure on the surface of the rock with some sharp-pointed instrument. (2.) The other method was to trace on the rock the object to be drawn, and then to grind it out by repeated rubbing with a piece of hard stone or pebble along the outline which had been traced.

(1.) A number of holes were first made close together along the outline of the figure to be drawn, and these were afterwards connected by cutting out the intervening spaces, thus making a continuous groove of the required depth and width. Judging by the punctured indentations made in the rock in cutting out the lines of these figures, I conclude that the natives had a hard stone or pebble, chipped or ground to a point, and used as a chisel.

(2.) In the Murchison district of West Australia, I am informed that outlines of the human foot and other designs are found scratched upon the surface of granite rocks. These outlines have apparently been worn into the surface of the stone by repeated rubbing with a hard sharp-pointed pebble held in the hand of the operator.

Probable Age and Significance.—From reliable sources I have satisfied myself that rock painting was practised by the aborigines for many years after New South Wales was first occupied by the English people. Judging by the comparative freshness of some of the rock carvings, I am not disposed to attribute any great antiquity to them.

I think it is highly probable that many of these native drawings are a rude kind of picture-writing, but, as our present collection of data is very limited, it will be better not to advance any theories until a very much larger and more varied number of paintings and carvings can be copied and described.

It is evident that these native drawings will become fainter and fewer year by year; hence it is very desirable that those who have opportunities, and are willing to give us the results of their investigations, should be encouraged by all learned Societies to copy and preserve these records of a people who are rapidly disappearing before the white race.

Plate I.—ROCK PAINTINGS.

By W. J. ENRIGHT, B.A.

In October, 1893, I happened to see in the newspapers the report of a paper entitled "Rock Paintings by the Aborigines in Caves on Bulgar Creek, near Singleton," which was read by Mr. R. H. Mathews before the Royal Society of New South Wales. This paper had the effect of awakening my interest in this subject, and a friend put me in communication with the author, who kindly sent me a copy of his paper, which was illustrated by plates, showing the paintings he described.* I then commenced to study aboriginal drawings; and having been informed that there were several of them in the Wollombi district, I determined to visit that locality immediately I had the time at my disposal. I am glad to say that I have been able to make two or three excursions through the country indicated, with the satisfactory result that I have prepared a paper in which are described nine groups of paintings, which will, I trust, be found interesting to the members of this Association. My colleague, Mr. Mathews, has undertaken the preparation of a plate of rock carvings, with descriptions of the various figures he has visited and copied; so that I shall leave that part of the subject to be dealt with by him.

Fig. 1.—The cave in which these drawings were found is situated in a cliff of Hawkesbury Sandstone on the right bank of Bally's Arm, a tributary of Cedar Creek, and about 25 chains westerly from the north-west corner of Portion No. 6, of 40 acres, in the parish of Millfield, county of Northumberland.

The length of the cave is 46 feet, height about 12 feet, and depth 20 feet. The front of the shelter faces N. 20° W., and the floor, which slopes to the edge of the cliff, is covered in places with one foot depth of sand derived from the disintegration of the rock, which is very fine-grained; there are also charred sticks, a great quantity of cinders, and shells of the fresh-water *Unio* lying about, together with flakes of smoke-blackened stone which have dropped from the roof, where slight traces of the smoke are still be be seen.

There are nineteen figures drawn in solid black, and they consist of a large fish surrounding the small figure of a man, and with the beak of a seagull in its mouth; a laughing jackass; a figure of a

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* Journ. Roy. Soc. N. S. Wales, vol. xxvii., pp. 353-8, Plates xviii.-xx

woman, the lower portion of which is somewhat weathered and one leg has entirely disappeared; a figure of the sun; a small fish; a bird, which appears to be a member of the cormorant family, in the grasp of a mud-turtle; and an elliptically shaped figure with numerous rays projecting, which may be intended for a porcupine rolled up, or possibly a moon in its third quarter; a small figure like a snake in the act of striking; one which bears a rude resemblance to a foot; four which may be dilly-bags or the light bark shields of the natives; one shaped like a waddy, except that the thick end is disproportionately wide; a figure somewhat triangular in shape, but the third side is represented by eight short parallel strokes; also a large figure to which I shall not attempt to give a name.

There are also some figures drawn in white, consisting of a man with portions of a leg and of one arm cut off, and holding a boomerang in the other hand; six tribal marks, each 10 inches long, in one group; eight, each about four inches long, in a second group; and two, about four inches long, in a third group. There are also three figures stencilled in white—viz., a boomerang, a stone tomahawk with handle attached, and a human hand and portion of an arm. There are also many slight traces of other figures left, but nothing definite can be made out from them. The first figure must have been drawn many years ago, for many are now about nine feet above the floor, but there is a vestige of a ledge or, perhaps, a former floor of the cave, about three feet above the present floor, still remaining, which, although not now sufficient to afford a foothold, must in former times have been sufficiently large to have been used as a platform by the dusky artists.

Although the Hawkesbury Sandstone weathers very rapidly in comparison with other rocks, the process of disintegration in relation to our own computation of time is very slow, for in another cave I was shown by a Cedar Creek resident a name which had been written with a piece of charcoal sixteen years ago, according to the date inscribed under it, but it was still as legible as the day on which it was written.

Fig. 2.—The cave in which these drawings are to be found is in the parish of Lockyer, county of Northumberland, about a mile westerly from Portion No. 3, of 40½ acres, of that parish, and about 80 yards from the right bank of a rivulet locally known as Cutta Muttan, and about 150 feet above the level of that stream, in which there is permanent water. The cave is one of those hollows so numerous in rocks belonging to the Hawkesbury Series, and its dimensions are as follow:—Height at the entrance, on an average, about six feet; length, 33 feet; and depth, from the entrance to the back wall, about ten feet; the floor is level, and consists of earth somewhat black in colour, which appears to be due to a quantity of cinders being mixed with it.

A quantity of cinders is also strewn over the floor, together with a few partly charred sticks, some small bones, and flakes of stone that have recently dropped from the roof, which is of a black colour, except where it has failed to withstand the action of the weather.

I was told by some of the local residents that this rock-shelter was the home of an aboriginal named Cutta Muttan (whence is derived the name of the creek) up to the time of his death about twenty-five years ago. For all we know, the old chieftain, who clung to the customs of his forefathers with a tenacity unusual in the members of his race, may have whiled away many a solitary hour in his rocky home there amongst the barren Hawkesburies, executing some of these drawings in the hope, perhaps, that they might keep green the memory of the gods of his race.

A certain freshness, by no means suggestive of age, which surrounds some of these drawings, and the conservative spirit said to be possessed by the old aboriginal, lead me to believe that the figures in this cave are the most recently executed of any described in this paper; but a long period must have elapsed between the execution of the first and last of these figures, as no less than 130 hands stencilled in white are distinctly visible. They are in various positions and very much crowded, in many cases being contiguous. There are also one or two blurred masses of white colour to be seen on the rock, in which a minute search discloses traces of fingers or other portions of hands which have at different times been stencilled on it. Time would not permit of my taking a sketch of the hands showing their positions relative to the other figures.

There are three hands with the arm as far as the elbow stencilled in white, and, judging from the appearance of one of them, the arm of the artist shifted at the critical moment; also a hand with a portion of a spear or waddy stencilled in the same colour in such a way that the junction between the two is not discernible; a tomahawk with the handle attached; a waddy or portion of a spear, and what appears to be a combination of spear and tomahawk, also stencilled in white on a black background, which I am sure has been produced by the use of a black colouring matter and not by smoke; for, as I have stated before, the execution of all the figures must have extended over a great length of time. Now, if the wall and roof had been blackened by the action of smoke, some of the earlier drawings would obviously have also been discoloured; but in no instance was this the case. A figure, which may be intended to represent the sun, is drawn in white with twelve distinct rays of unequal length, and a shapeless mass is attached to it, which may have been caused by a bungle of the artist in drawing another ray; other drawings are—a large figure very rudely drawn in white, which resembles an opossum; a bird in the act of swimming or flying, and a large figure of a man about five feet ten inches high, both drawn in black; two figures (one with the lower portion weathered away) drawn in red, which resemble in all respects the other figures of men I have seen drawn by the aboriginals, with the exception of the head, which in one of them is shaped like a cocked hat, and no features are visible in either of them; a drawing in red, which resembles a two-headed leangle, or pick-shaped club, which was in use amongst the aborigines of Victoria, but I have never heard of this weapon being used by the tribes of New South Wales; and, lastly, a figure drawn in red, which at a first glance looks like a coiled snake with head upraised.

There are altogether about 145 figures in the cave, including 130 hands, which is the greatest number I have ever seen in any one rock-shelter.

Fig. 3.—These drawings are to be found in a crescent-shaped hollow, facing northerly, in the Hawkesbury Sandstone on the St.

Alban's road, about a mile southerly from Portion No. 3, of 40½ acres, in the parish of Lockyer, county of Northumberland. The cave is about 80 feet long, about 20 feet high at the extreme edge of the ledge which forms the roof, and about eight feet in depth from the edge of the floor, which consists of earth and is quite level, to the back wall, but the depth was originally much greater, as portion of the floor had recently to be cut away in forming the roadway.

The cave is a favourite camping-place of white men, who have drawn many figures on the wall with charcoal; but an old resident of the district informed me that the only figures in the cave when he first saw it were the three which I have described in this paper.

From the appearance of these figures I think that the red colouring matter with which the outlines were drawn was in a liquid or semi-liquid condition, but that the remaining portions of the figures have been drawn in red and black with a solid substance. The figures consist of a kangaroo and two men, one of whom has the nose, eyes, and mouth drawn, and the other the eyes and mouth only. I found on the floor a couple of pieces of the shell of a species of fresh-water *Unio*, and some charred sticks, but the latter may have been brought there by white men.

A local resident informed me that this cave was never known to be used as a camping-place by the blacks, who regarded the country lying between the above-mentioned portion and what is now the southern boundary of this parish as haunted, and, whilst they hurried through it in daylight with a speed induced by superstitious terror, nothing whatever would make them traverse it at night-time. This dread of something supernatural, and the fact that there is on the roof of the cave a stalactitic growth produced by a constant drip of water, may have been the reason why no more figures were drawn in this cave, although it is of such great size.

Fig. 4.—This rock-shelter is a mere hollow in the Hawkesbury Sandstone, with a floor sloping at such an angle that it is difficult to obtain a foothold in it. It is situated within Portion No. 40, of 40 acres, in the parish of Lockyer, county of Northumberland, facing N. 20° E., and is of the following dimensions:—Length, 26 feet; height, 10 feet; and depth, 13 feet.

There are four right and three left hands stencilled in white, a figure drawn in white which resembles a kangaroo rat in the act of feeding, another marsupial in an unfinished condition also drawn in white, and the figure of a man as far as the waist drawn in red with the mouth in white; this last drawing commences from a small rocky ledge, and may be intended to represent a man rising up from a pit. There is permanent water in Mogo Creek and a small tributary of it known as Reedy Gully, which flow through the grassy flat in front of the cave, which in former times must have been a veritable blackfellow's paradise.

Fig. 5.—This figure is drawn on the side of a small hollow in a boulder of Hawkesbury Sandstone lying on the slope of a hill, about 300 yards westerly from the junction of the Mogo Creek with a small stream forming portion of the south-eastern boundary of Portion No. 14, of 40 acres, in the parish of Lockyer, county of Northumberland. The rock-shelter, which faces in a northerly direction, communicates with a cave on the southern side of the boulder by a small aperture about 18 inches high, but there is no trace whatever of drawings in the latter.

The only drawing visible is that of a man in black on the back of the cave. The upper portion of this figure extends over smoke-blackened rock, but the background of the lower portion of the figure being somewhat light in colour the artist has made up for the deficiency by drawing lines in black longitudinally through the figure. Other figures have been drawn in black and also in white in this cave, but they have been almost entirely obliterated by cattle which used this place as a camping-ground.

Fig. 6.—A cave in the Hawkesbury Sandstone, forming a crescent-shaped hollow, is situated about a quarter of a mile due east from Portion No. 14, of 40 acres, in the parish of Lockyer, county of Northumberland, and is of the following dimensions:—Length, 117 feet; height, about 20 feet; and depth, 24 feet. The floor is of rock, which in places is covered with sand derived from the weathering of the roof, which is of a rough uneven nature, and altogether an unfavourable place for the execution of these drawings. The roof is also blackened in places by the smoke from the camp fires, of which there are a few traces remaining in the shape of cinders and partially burnt sticks.

The percolation of water through this sandstone—in places giving rise to a stalactitic growth—has caused this rock to weather very rapidly, destroying many drawings, portions of which can be seen on flakes of stone that have dropped from the roof and walls. At certain seasons also the drop was not inconsiderable, for well-known grooves on the rock show that at times there has been sufficient water in the hollows on the floor to enable them to sharpen their stone tomahawks around them.

There are still twenty figures, all drawn in black, distinctly visible in this rock-shelter. The greater portion of the first figure on the extreme left has disappeared, leaving only the head and forepaws remaining; but from their size and appearance I believe that the figure to which they belonged was intended to represent a kangaroo or a wallaby. To the right of the last figure there is a small marsupial drawn in the act of running, and what appear to be a slut and a dog, the latter with the extremities of the legs worn away; such a small portion of the figure immediately to the right of the dog is remaining that I will not hazard an opinion as to what it was intended to represent. There is also a large figure, with a tail and four paws extended, which might be likened to a turtle drawn on a large scale, and the three figures above it resemble members of the rat tribe. The figures in the southern portion of the cave consist of a kangaroo, a human hand, a man holding one end of a spear or waddy in his hand and the other touching a kangaroo in the act of jumping, a small animal resembling a dog, a bird like a parrot but with a rather long tail, an animal not unlike a kangaroo minus the forepaws, a human hand and portion of the forearm, two small creatures with only the outlines drawn, whose respective genera would be difficult to determine, and one whose upper portion resembles the usual aboriginal drawing of a woman and the lower that of a man.

Fig. 7.—The cave or rock-shelter in which these figures are drawn is situated within Portion No. 11, of 40 acres, in the parish of Corrabare, county of Northumberland, in an escarpment of Hawkesbury Sandstone, about 400 yards from Wollombi Brook, in which there is permanent water.

This cave, facing north-west, is 64 feet long, 16 feet deep, and about 16 feet high, with a floor consisting of earth, on which are strewn cinders and some shells of the fresh-water *Unio*, which was, I am informed, considered a delicacy by the aboriginals.

There are three left hands and one right hand stencilled in yellow and six left hands stencilled in white on a black background produced by the action of smoke on the wall. The snake drawn in white in this cave resembles the figure of a snake carved on the Bora ground shown in Plate III. accompanying the paper on the Bora,* read before the Royal Society of New South Wales in July, 1894, by Mr. R. H. Mathews; the four remaining figures, represented in Fig. 7A on the plate, whose outlines are drawn in white and the rest of the figure in black, are, I believe, intended to represent the tails of the male lyre birds, which are found in great numbers around this place. There is also trace of another figure drawn on the wall, but as it is apparently in an unfinished condition it is impossible to say what it was intended for. Three hands stencilled in white complete the drawing.

Fig. 8.—These drawings are displayed in a cave situated in Portion No. 18, in the parish of Corrabare, county of Northumberland, and is only a short distance from the Wollombi-Maitland road. This rock-shelter, the floor of which consists of sand, mixed with ashes and strewn with fragments of bone and mussel-shells, is of the following dimensions, viz.:—Length, 42 feet; depth, 22 feet 6 inches; and height, 12 feet.

In addition to the drawings which I have reproduced there are in this cave indications of a few other figures, some apparently of women, drawn in red and white, but too much weathered to be copied with any degree of accuracy.

Fig. 9.—In a small rock-shelter on Narone Creek, in the parish of Corrabare, county of Northumberland, within a grant of 320 acres to Robert Milsom. The hands, arms, and foot shown in this figure have been stencilled. The cave is in a rock forming portion of the talus-slope of the valley through which the creek winds its way, and is very small, being only 5 feet 6 inches in height, 12 feet long, and 6 feet 3 inches in depth. Besides the figures shown there are visible traces of five hands and of some red and also black lines (perhaps tribal marks).

My principal object in preparing this paper is to record some of the strange characters now rapidly disappearing in such a way that the student of anthropology in the future may be assisted in piercing through the mists of obscurity surrounding the origin of our native races. In different parts of the Wollombi district, where I found these paintings, I also discovered several rock carvings, which I intend to describe in a subsequent paper.

It is now generally agreed that the figures in black are drawn with a mixture of charcoal and animal fat, and this is perhaps the compound that is used in preparing the black background for figures to be stencilled on.

In each of the caves containing the drawings shown in Figs. 2 and 3 I found a small piece of soft sandstone of a reddish colour that is very rarely seen in any of the rocks of the Hawkesbury Series, and

* Journ. Roy. Soc. New South Wales, xxviii., pp. 98-129.

the fact of it being found in the same caves as the red figures inclines me to believe that stone of this kind has been used in the composition of the red colouring matter with which some of the figures in those caves have been drawn.

The stone itself has a red streak not unlike the colour of these figures, and a drawing might be rendered durable by first smearing the rock with grease and then drawing the figure on it with a piece of this stone.

Under conditions approximating to those under which the aboriginal artists laboured I have stencilled objects resembling those described by smearing the rock with fat, and then, having placed the object to be pictured on the greasy surface, I have blown flour in a dry state on to the rock around it. The only difference between those I have produced myself and those I have seen in the Wollombi district is a certain dinginess of colour in the latter, for which time alone would account. The aboriginals may have obtained the white powder by crushing white pipeclay, two beds of which are to be found in the Wollombi district at the base of the Hawkesbury Sandstone beds, and at the outcrop the pipeclay is often so stained by iron that it could be used to produce the yellow colour in which some of the hands are stencilled.

Although our aboriginals had no written language in our sense of the term, yet in some instances it has been shown (notably in "The Aborigines of Victoria," by Brough Smythe) beyond a shadow of a doubt that they are able to convey their thoughts to one another by means of characters carved on wood. In the paper above mentioned on the Bora ceremony, by Mr. R. H. Mathews, there is given an example of pictography; but as the aboriginal artist had been in contact with civilisation too much value should not be placed on this as a proof that they understood that art. I have also heard, although on rather doubtful authority, that the natives of Western Australia are able to communicate with each other by carving figures of animals on trees. No doubt many of these figures are fanciful, and many representing objects familiar to the aboriginals may have been drawn merely for pleasure; but it is hard to believe that the hands which we find stencilled in groups varying in number and in the relative positions of the individual members of the group—and that those series of lines called tribal marks to be seen varying in number and length—are without meaning.

Plate II.—ROCK CARVINGS.

By R. H. MATHEWS, L.S.

The number and variety of the cave *paintings* discovered and recorded by Mr. Enright render it unnecessary for me to add any further examples. I will therefore proceed to describe a large number of aboriginal rock *carvings* discovered by myself. All the carvings shown on Plate II. are situated in New South Wales, and, unless otherwise stated, are in the county of Cumberland. They are all carefully reproduced to a given scale, a copy of which is drawn upon the plate. The position of each carving on the public maps is stated in the descriptions.

Fig. 1.—The group here delineated is situated on the road from French's Forest to the Pittwater road, joining the latter at Portion No. 64, of 640 acres, in the parish of Narrabeen, county of Cumberland, New South Wales. The carvings are on a flat rock of Hawkesbury Sandstone, on the eastern side of the road, a short distance southerly from the southern boundary line of the portion referred to, which line also forms the boundary between the parishes of Narrabeen and Manly Cove—these carvings being, therefore, just within the last-named parish. They are only a few yards from the roadside, and are visible to anyone passing along it.

The central figure of this group represents a man, who, if the legs were straight, would measure about 7 feet 6 inches high. He wears a belt, and there is a band around the left arm at the shoulder. Part of the right arm and hand are barely distinguishable. Beside him is the figure of a woman, about the same height, whose body is marked by a number of stripes extending from the breast downwards to the feet. The mammæ are delineated in the way usually observed in native drawings. The eyes and mouth are shown in both figures. Above the heads of the man and woman is the representation of a shield 2 feet 4 inches long, and 1 foot wide in the middle, with three transverse bars marked upon it. On the right of the man is an animal somewhat resembling a kangaroo; but it may have been intended for a dog. It measures 5 feet 10 inches from the end of the tail to the nose. There is a line marked on the body of this animal, extending from the neck about 2 feet 6 inches towards the tail.

The figures of the man and woman have their arms and legs extended in the attitude usually assumed by the natives at the corroboree dances, and the stripes on the woman's body may be intended to indicate the painting of the body and limbs usual on such occasions; or perhaps they were merely added for the purpose of ornamentation by the native artist who carved this group. Mr. R. Sadleir says:—"There are many kinds of corroborees. All have the song and the dance; both are at times very libidinous, especially the dance of the women."—*Aborigines of Australia*, p. 19. The Rev. J. Mathew says:—"Some corroborees are lewd in the extreme, and it is generally understood that at such times sexual restrictions are shamefully (or, from the native point of view, shamelessly) relaxed."—*Journ. Roy. Soc. N. S. Wales*, xxiii., p. 417.

All the figures shown in this group are cut into the surface of the rock in the manner explained in a previous page of this paper, but have suffered considerably from the natural decay of the sandstone. The plate is drawn to scale, from careful sketches and measurements taken by myself, and shows the group in correct relative positions exactly as drawn upon the rock.

Fig. 2.—This drawing represents five birds, probably ducks, on the wing. The largest is 1 foot long, and the smallest about 9 inches. They are carved on a large horizontal rock, a few yards on the western side of the old road from Peat's Ferry to Sydney, about a mile and a-quarter northerly from Vize Trigonometrical Station, parish of Cowan.

Fig. 3.—This rude representation of a human figure, wearing a belt, is carved on a fine-grained sandstone rock, almost level with the ground, sloping gently towards the north, on the top of a rough,

rocky spur, about three-quarters of a mile north-easterly from the north-east corner of Portion No. 50, of 40 acres, parish of Broken Bay.

Fig. 4.—This interesting carving represents a side view of a human being in a sitting position; one leg is shown, but both arms have been omitted. An attempt has apparently been made to show a profile of the face, but both eyes are visible on the same side. Eight ray-like lines, about 5 inches long, probably to represent ornaments worn in the hair, rise from the top of the head. The carving is on the level surface of a rock close by the eastern side of the road from Peat's Ferry to Sydney, and about a quarter of a mile northerly from Vize Trigonometrical Station, parish of Cowan.

Fig. 5.—The remaining lines of the human figure here depicted have been completely obliterated by the erosion of the rock. This carving is on a large rock, sloping north-easterly, on Portion No. 1139, of 24½ acres, parish of Manly Cove.

Fig. 6.—The man or boy here represented is carved on a rock, sloping westerly, at the head of a small freshwater gully flowing north-westerly into Cowan Creek, and is about half-a-mile in a south-westerly direction from Wallaroo Trigonometrical Station, parish of Broken Bay. The height is 2 feet 6 inches, and the drawing is interesting on account of both feet being turned in the same direction.

Fig. 7.—This is another attempt at producing a profile of a human figure, apparently in a sitting position, only one leg and one arm being shown, as in the carvings of kangaroos and other animals. The short line at the lower end of the body may have been a commencement to draw the other leg, but this was not proceeded with. The length of the head-dress is 12 inches. This is one of a number of carvings of different objects on a large horizontal mass of sandstone, on a bridle-path from Mangrove Creek to the Hawkesbury River, parish of Spencer, county of Northumberland.

Fig. 8.—Represents a native shield, 3 feet 11 inches long, and 10 inches at its greatest width. There is a longitudinal and three transverse bars cut upon it. This carving is on top of a large boulder with a convex surface, about 150 yards south-easterly from the Hawkesbury Railway Station, within Portion No. 9, of 100 acres, parish of Cowan.

Fig. 9.—This oval object, 6 feet 11 inches by 5 feet, is carved upon a flat rock level with the ground, about five or six chains south-westerly from the last described.

Fig. 10.—It is difficult to determine what animal this carving is intended to represent; except for the length of the tail it resembles the wombat, and was probably intended for that animal. It measures 6 feet 3 inches from the nose to the end of the tail. This carving is on the face of an almost vertical rock close to the left bank of Calabash Creek, at its junction with Berowra Creek, parish of Berowra.

Fig. 11.—This is another animal the identity of which it is difficult to determine, but it is probably an opossum. Its length from the nose to the tip of the tail is 5 feet 5 inches. It is carved on a flat rock within Portion No. 1140, of 40 acres, parish of Manly Cove.

Fig. 12.—This well-executed drawing of a wallaby is carved on the same rock as Fig. 6; its length from the nose to the end of the tail is 4 feet 4 inches.

Figs. 13 and 14.—The rudely drawn animals here represented are probably intended for kangaroo rats. They are carved on a rock, sloping slightly towards the north-east, within Portion No. 75, of 34 acres 3 roods 20 perches, parish of Gordon. On this rock is a hole of permanent water, filled by a small stream running over it, close to the margin of which are about thirty hollows worn into the rock by the aborigines sharpening their stone hatchets upon it.*

Fig. 15.—This well-executed carving of a kangaroo rat or wallaby, 3 feet 1 inch in length, is drawn on the same rock as Fig. 2.

Fig. 16.—A kangaroo rat, carved on an extensive flat rock level with the ground, four or five chains to the east of the old road from Peat's Ferry to Sydney, and about a mile and a-quarter northerly from Vize Trigonometrical Station, parish of Cowan.

Fig. 17.—I think this small animal is intended for the echidna or hedgehog, as I have seen several similar carvings in various places and have described them elsewhere. It is on the same rock as Figs. 6 and 12.

Fig. 18.—It is difficult to determine whether this drawing is intended to represent a bird on the wing, or some kind of a fish. It is carved on the same rock as Fig. 16.

Figs. 19 and 20.—These two shields, one of which is 4 feet 1 inch and the other 2 feet 7 inches in length, are carved on a flat rock about half-a-mile north-westerly from Cooper Trigonometrical Station, parish of Frederick. Neither of them has the longitudinal or transverse bars usually seen on similar carvings.

Figs. 21 to 24 represent a shield and three boomerangs, carved on the same rock as Figs. 16 and 18. The boomerang shown in Fig. 24 has a line along the middle, probably for ornament.

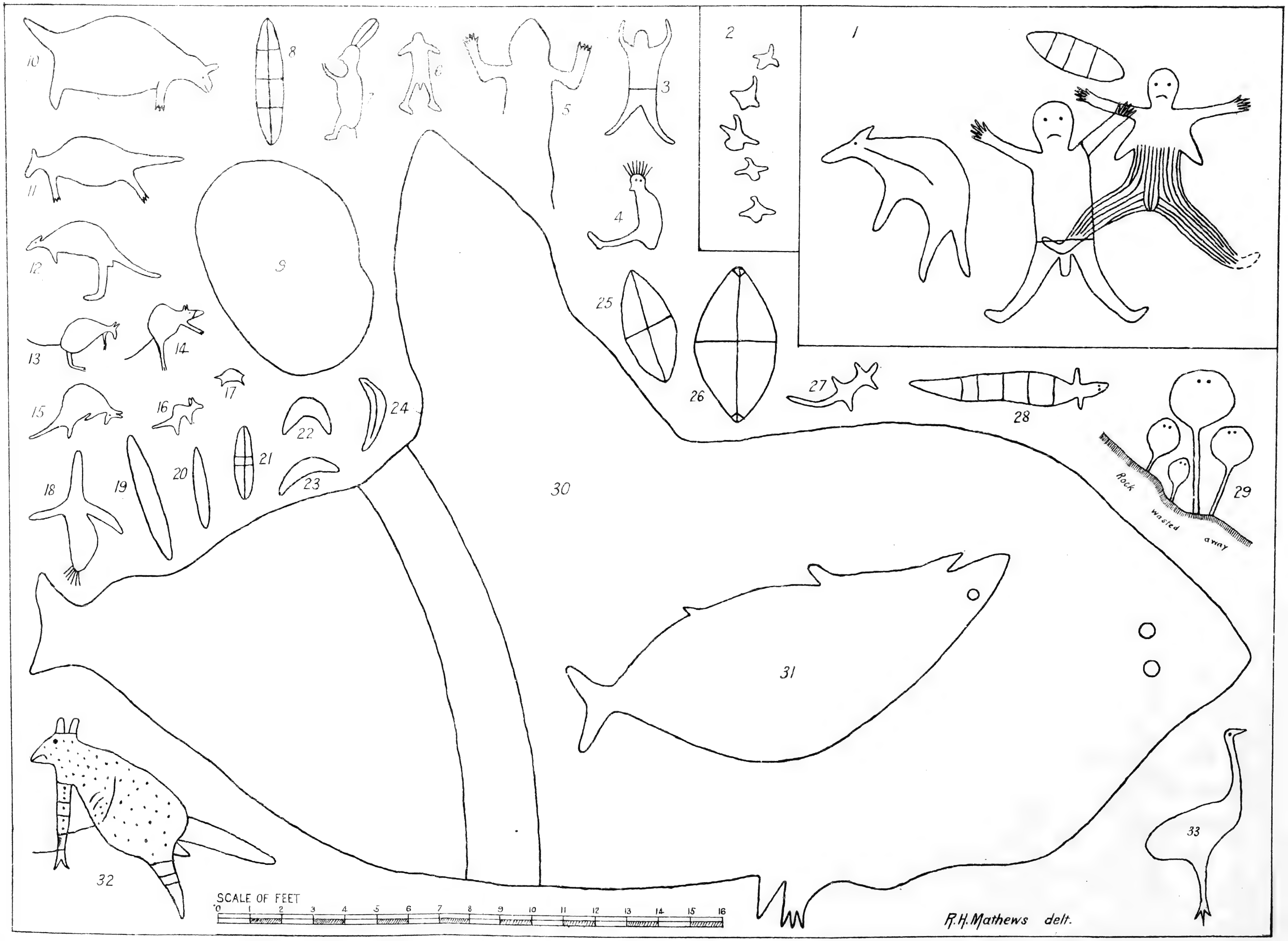
Figs. 25 and 26 are two shields carved upon a large mass of sandstone on the western side of the old dray-track leading from Portion No. 71, of 100 acres, parish of Broken Bay, to Tabor Trigonometrical Station. The surface of the rock slopes gently towards the north-east. Attention is drawn to the triangular spaces at each end of Fig. 26, which are not very common.

Fig. 27.—This representation of a large lizard is carved on a flat rock level with the surrounding land, about three chains southerly from Fig. 8.

Fig. 28.—This carving, which is evidently intended for an eel, is 6 feet 4 inches in length, and its greatest width is 1 foot. The pectoral fins and eyes are shown, and there are five bands cut across the body, apparently for the purpose of decoration. It is on the same rock as Fig. 4.

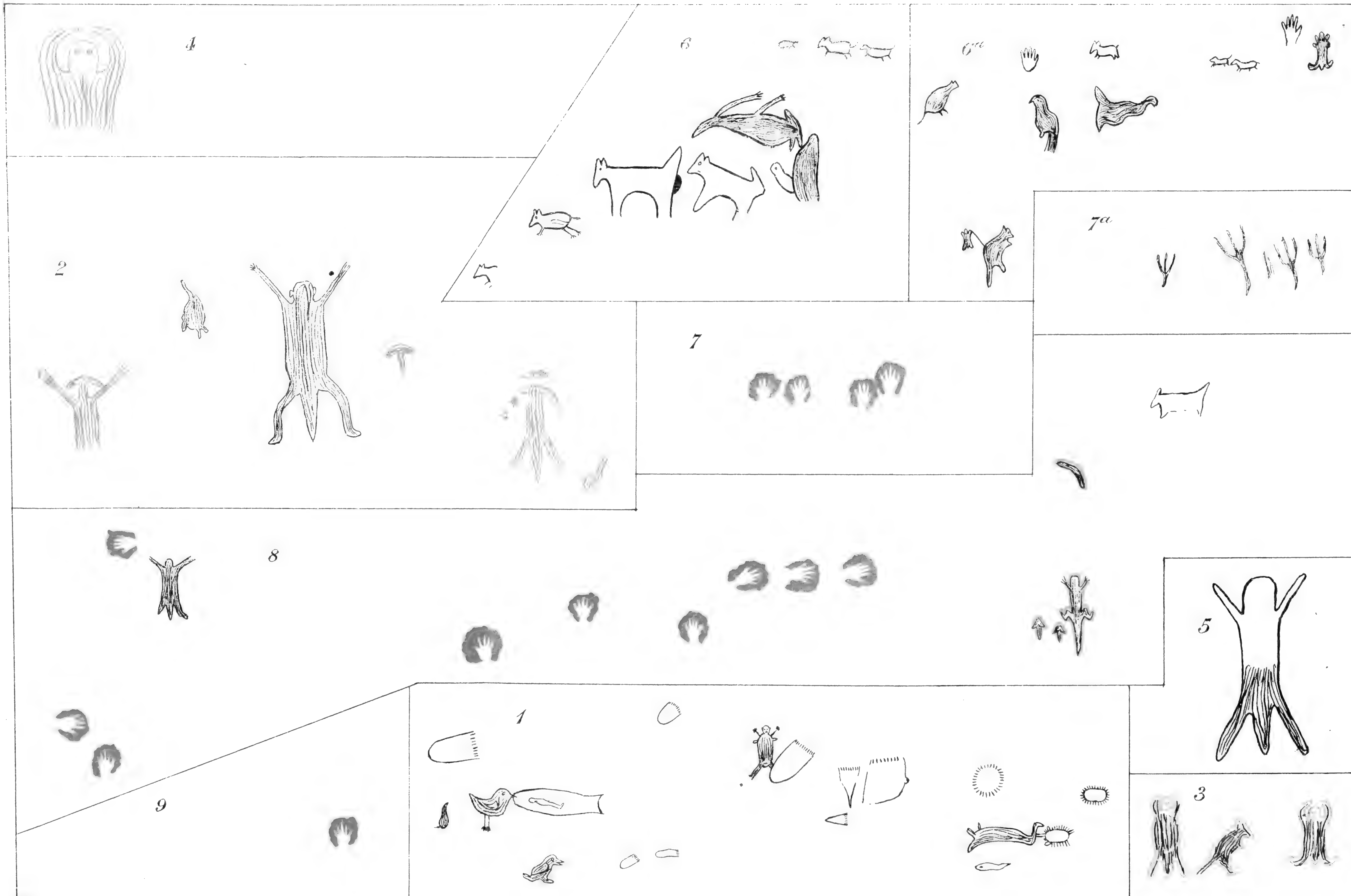
Fig. 29.—The group of four sting rays here depicted is carved on a rock a little above high water on the southern shore of the Hawkesbury River, at a place known as Kangaroo Point, and is within Portion No. 11, of 10 acres, parish of Cowan. The rock on which they are drawn has a slope forming an angle of about 25 degrees with the horizon. Both the eyes are shown in each fish, and in all of them a portion of the tail has been carried away by the natural decay of the rock, as indicated on the plate.

* For full descriptions and drawings of similar native grinding-places, see my paper on "Some Stone Implements used by the Aborigines of New South Wales," published in the Journal of the Royal Society of New South Wales, vol. xxviii. pp. 301-305, plate xliii., fig. 3.



E & M. I.

Aboriginal Rock Carvings of Australia.



Aboriginal Paintings of Australia.

Fig. 30.—This immense fish is carved on the flat surface of a mass of sandstone bounding the shore of Botany Bay at La Pérouse, about half-way between Frenchman's Bay and Bare Island, within the reserve for defence purposes, parish of Botany. Its extreme length is 38 feet 8 inches, and the width of the body, not including the fins, is 14 feet. There is a huge dorsal fin upwards of 10 feet in length, and a pair of pectoral fins, one of which is notched at the end. Two slightly curved lines extend across the body, similar to those shown in Fig. 28, and both eyes are drawn on the same side of the head, a practice not unusual in native pictures of various animals. The surface of the rock is uneven, and the erosion caused by water running along the depressions during wet weather has almost obliterated some of the outlines here and there. This carving is about 8 chains in a south-westerly direction from the La Pérouse monument.

Although this fish is 3 feet 10 inches shorter than one I have described elsewhere, it covers a greater area of the rock surface, owing to its immense width, than any fish yet recorded. See the fish represented in Plate IX., Fig. 15, annexed to my paper on "Aboriginal Rock Paintings and Carvings in New South Wales," published in Proc. Roy. Soc. Vic., vol. vii. (n.s.), pp. 154-155.

Fig. 31.—Within the outline of the fore part of the body of Fig. 30 another fish has been carved upon the rock in the position shown in the plate. Its length is 14 feet 6 inches, and its greatest breadth 5 feet 6 inches. An eye, which consists of a circular ring like those of Fig. 30, a pectoral, and a ventral fin are represented. Whether it was intended to convey the idea that this fish had been eaten by the larger one, or whether it was carved in its present position owing to the suitability of the rock surface, it is difficult to form an opinion; the latter is the most probable.

Fig. 32.—This grotesque figure of a kangaroo is carved on a detached boulder of Hawkesbury Sandstone lying on the slope of a rocky hill within Portion No. 163, of 40 acres, parish of Cowan. The side of the rock containing the drawing slopes away from the spectator at an angle of about 15° from the perpendicular, and faces N. 70° W. It is about a chain from the left bank of Berowra Creek, in a small indentation in the shore line, called, from this native carving, Kangaroo Bay. The length of the animal from the nose to the end of the tail is 8 feet 5 inches, and the body is ornamented with dots and lines cut into the rock. There are three bands across the hind leg, and five across the fore leg, two of which extend beyond the sides of the latter limb. The mouth, an eye, and both ears are tolerably well delineated. Some of the lines of this figure are cut into the rock about an inch and a-half, and are about two inches wide, being some of the deepest and widest grooving I have yet observed in native carvings.

Fig. 33.—The well-drawn emu here represented is carved on a large flat rock about half-a-mile northerly from the north-west corner of Portion No. 6, of 50 acres, parish of Wonga, county of Hunter. The bird measures 4 feet 10 inches from the bill to the tail, and 6 feet 8 inches from the bill to the end of the foot. This carving has been described by me in my paper on "The Aboriginal Rock Pictures of Australia," published in Proc. Roy. Geog. Soc. Aust. Q. Bch., vol. x., p. 66, plate iii., fig. 2.

7.—NATIVE TRIBES OF PORT DARWIN AND ITS NEIGHBOURHOOD.

By T. A. PARKHOUSE, formerly Accountant and Paymaster, South Australian Government Railways, Port Darwin.

Distribution.—The territory of the Lárraki'a,* in which Port Darwin is situate, embraces the seaboard from Shoal Bay to Southport, and extends inland to the forty-sixth mile on the railway line, the Waggait, whom both the Lárraki'a and Awárra detest, being their westerly neighbours. The Wúlna*r* tribe occupy the country to the east of the Lárraki'a, from Marrakai cattle station on the Adelaide River to Shoal Bay and thence along the coast to beyond Escape Cliffs, their easterly neighbours being Alligator River blackfellows. The Lárraki'a and the Wúlna*r* are allied tribes, between whom intermarriages are frequent.

At near Rum Jungle, on the railway line, and south to the Howley, is the country of the Awárra, who have the Berrigúrruk, or Mary River tribe, to the east. South of the Awárra, from Fountain Head to Pine Creek, are the Awinnmul and Aggrakúndi; their country extending near to the Evelyn, which is within the borders of an Alligator River tribe. Between the Aggrakúndi and the Daly River are the Aggagowilli, and south the Adowen and Méanagi, whose position I am unable to locate. The Awinnmul are natives of Burrundi, and at one time were a tribe distinct from the Aggrakúndi; but one disastrous season decimated the Awinnmul, and greatly reduced the number of the Aggrakúndi, resulting in the amalgamation of the two tribes. It has been said that the Aggrakúndi headman, Manuel, is the last of the Awinnmul tribe, but I have reasons for doubting whether more was meant than that he was the last representative of a family group in that tribe.

The Awárra, Awinnmul, and Aggrakúndi have been hitherto known to Europeans only as Wulwóngga, and a member of either tribe so designates himself, keeping secret the fact that the Wulwóngga are subdivided. My Lárraki'a boy, in whose camp at Southport had lived for years the son of an Awárra woman, knew him only as a Wulwóngga until I referred to him as an Awárra; they spoke in Lárraki'a, and I heard my boy question it and the answer in confirmation. The tongues spoken by the Awárra and by the Aggrakúndi or Awinnmul are distinct, although with more affinity than Lárraki'a and Wúlna*r*, and I can discover no closer tribal relationship than that existing between those tribes. Why the two latter should set forth their autonomy and the former obscure it remains to be determined; the reserve maintained by the Wulwóngga inclines one to look for class marriage in explanation.

Notes Principally Concerning the Lárraki'a.—Between the Lárraki'a and the neighbouring tribes a neutral zone of some eight or ten miles is reserved, upon which no habitations are erected, game remains unmolested, and none trespass without good reason. I gather —although my inference is upon this point from insufficient data, and,

* The aspirate, indicated by the sign (') is often associated with the sound of *y* in the native tongues, and a letter italicised is often elided, or only indicated; thus these names have been spelled Larreekeeyah, Larrakeeha, Larrikia, Woolna, Woolner.

if correct, needs verification—* that with permission granted it may be used as a highway for a tribal journey, and game and other food may at such time be taken from it to supply the needs of the band travelling upon it.

The land is subdivided among the several families, with territorial rights, and the ownership is a real one. I have heard strong expressions of dissatisfaction at a friend who had outstayed his welcome, and it was forcibly put to him that food was not so plentiful that his presence was any longer desirable. During the wet season a good number congregate at Port Darwin; but, the "season over," the several members of a family, with the exception of those engaged by the whites, may usually be found "sitting down,"† at one of their country residences upon the ancestral manor. These are wurleys of the usual construction, made of bark, in section egg-shaped, and arranged in a circle or segment of a circle, the openings being towards the centre. "Hunting boxes" or "fishing lodges" are formed of boughs thatched with grass or reed.

At Port Darwin, on the Lammerru Beach, as it has been for generations, is the camp of the family in whom that part is vested, among them being also descendants of black trackers introduced by the police from the McArthur or other districts. A half-mile distant, at the head of Smith and Cavenagh streets, is the main camp of the Lárraki'a, comprising several circles of wurleys (at one time four circles, with from three to seven wurleys forming the circle or segment), and another quarter of a mile on, towards Point Emery, was at the same period the camp of the Daly family. About 150 yards removed from the Lárraki'a main camp north is a second camp, containing three circles of wurleys, in which reside Wúlnars, related to the Lárraki'a by alliance or descent. One of these is occupied by the family named after Emu, a headman of the Wúlna*r*, who, although spare, stands 6 feet 7 inches in height; the second by the family of another Wúlna*r* headman whom I know only as the brother of Mínnergwón-gwa (a savage of 6 feet 1 inch, splendidly built, not to be trusted) and father of Lóng'ába; the third I can identify only by two boys, W'ánnung-a and Mánnmitt. Another Wúlna*r* camp has been formed in the scrub on the north-east side of Cavenagh street, which is frequented by natives of that tribe coming in from the bush who are not related to the Lárraki'a.

At the camps each circle preserves its privacy, and the blacks to be seen within it are members of the family, or visitors who are tribal brothers; even the children in their play together do not go to each other's houses, but whistle or call from without. The camps are not kept particularly clean, but human or canine excreta does not defile them, and the dogs devour the bones or other refuse from a meal; both males and females, however, urinate in close proximity, whites not being present, unabashed, and without concealment of the action or parts.

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* The usual highway may have been for some distance only upon the neutral belt, and not the belt itself the highway for Alligator River blacks, for instance, proceeding to Port Darwin from Burrundi.

† This turn of expression would seem to prevail over the whole continent; where we say a man is living at Burrundi, the black says he is "sitting down."

As Emu's brothers are likewise referred to, and give their names as Emu, and as the Solomons and Dalys are numerous, and there are several Slocums, it may be inferred that there are distinctive native family or group names. Although I am inclined to think that this is the case, all attempts to elicit them have failed. Two of the sons of the Wúlna*r* headman Emu are named Dl'innmánnagwa (Benedict) and L'uérdwoa (Francis); it will be interesting to observe whether these young boys retain those names in manhood, and whether the headship descends to either.

The following incident may possibly have reference to names or to totems. My boy being told to remove a green jumping frog, and misunderstanding my remark, besought me not to kill it, alleging, "That one my father." His father was long dead. Upon my remarking that he had killed one at the office, which I still think was of the same species, he waxed indignant, and laboured to assure me that "This one my father indeed (*godloa*, truly); that fellow no belong to me." Some months after, he pointed out a pigeon to me: "See that fellow? him my father"; and, upon my recalling the incident of the frog to his mind, he replied, "That all right; him my father, this one another father. Whitefellow no savee." I could not ascertain, nor do I think, that his father or father's brothers bore their names, and totemism is denied, either personal or for sex or clan.

A widow and orphans are kept alternately by her own and by her deceased husband's family, and in some instances I know the time of relief is eagerly looked for. This rule also obtains when the parents belong to different tribes; the children, however, are of their mother's tribe. Keddéll, the son of an Awárra woman whom a Lárraki'a had stolen for wife, is an Awárra. His parents both died in his infancy, and until puberty he was brought up principally by his father's family; he now lives with the Awárra, but in the Lárraki'a camp when he visits his father's people he takes his place of right in their circle. A Wúlna*r* by his first wife had two sons and two daughters, and later by his second wife, a Lárraki'a dwelling on the Elizabeth, two sons—Berber and Lemállagwa. He and his first wife are dead, and his issue from both marriages have resided with the brother of the second wife, who remains a widow. I cannot say whether the first wife was a Lárraki'a, but all the issue are Lárraki'a; one of the daughters has some knowledge of the Wúlna*r* tongue, the others have forgotten it. The widow's brother has now taken to wife a Wúlna*r*, a girl of thirteen, named Minn-gári, unable to speak in Lárraki'a. L'uérdwoa, a Wúlna*r* previously mentioned, and Lemállagwa are tribal brothers, but in fact their parents were not brothers or sisters.

Infants are betrothed spouses, and in some cases the bestowal is made, sex being favourable, antecedent to birth. My boy at one time pointed out a blackfellow going past the veranda, and said, "Suppose me a lubra, that one my husband (*naow'a*)." To my inquiry, "What name that blackfellow?" with a view to investigation from other points, I was met with—"Oh, him blackfellow," and I could obtain no more. At another time he said of a boy, "Suppose that fellow a girl (*bun-ngógolo*), him my wife (*álledikk*)." Somewhat similar observations were casually addressed to me by others, who, seeing I was interested in the subject, at their own time and with just as much as they thought it desirable for me then to know, proceeded thus, placing stones where the asterisks are, to illustrate the genealogy of one pair :—

That one him married man (*móllinnyu*)		*	
Him have two-fellow lubra	*	*	
That fellow lubra him have em boy (*nimm*)	*	*	Him lubra have em girl (*bun-ngilla*)
By-and-by him catch him lubra, him have em boy (*nimm*)	*	*	By-and-by girl big fellow, him husband (*nuone‘a*) catch him, him pregnant (*méloa*), have em girl (*bun-ngilla*)

By-and-by *nimm* big fellow, by-and-by *bun-ngilla* big fellow, him catch him. These would be half first cousins, a relationship, I believe, within the blood-tie in which marriage is unknown; but it is not to be understood that the relationship was so close, the black indicating the line of descent and not the number of degrees. These details were given, not extracted; a Lárraki‘a was explaining the matter, and an Awárra who was present verified his remarks. In three instances the cases were certainly specific, although they may point merely to ante-natal agreements entered into by the parents; the others may have been and probably were generic, indicating that the persons referred to were within the group from which the speaker was entitled to a wife.

It was but a few weeks before my departure from Port Darwin that this subject was introduced, and I was unable to follow up the genealogy. It would be well for anyone in a position to do so to prepare tables on which the native name, sex, apparent age, circle in camp, tribe, and, as it was learnt, the relationship to other blacks would appear; with such charts intermarriages between the Lárraki‘a and Wúlna*r* would soon be clear, and, to one apparently in possession of the facts, instead of the reserve manifested, interest in making other points intelligible would be exhibited. It would indeed appear possible only by piecing together details such as those given to arrive at any definite results. After thirty years of occupation and much patient study, the foregoing pages contain almost the sum of our knowledge concerning the laws governing marriage, and, bare as are the facts, there is a distinct advance on previous information. All who have made the attempt will admit the difficulty of obtaining from the Lárraki‘a or Wúlna*r* any information upon tribal matters. Confidence is freely given to those whom he esteems, and much kindly interest is taken in imparting his lore, but his confidence is not to be forced, and questioning must be only conversational. Affection prompts the boy to make his master (whom he regards as an elder brother) "close up blackfellow," and he instructs him as he is sympathetic to his teaching, not in gratification of curiosity.

Children live with their parents until puberty, when girls become members of their husbands' household, residing sometimes with him, and at other times at the parental camp Their virginity is respected until the breasts are fully developed; they become mothers at from sixteen (perhaps sometimes fifteen, but rarely, if at all) to eighteen. Before coverture a corrobboric is held, and the ceremony of marriage by capture is observed; I think, but cannot definitely say, that this custom is invariable.

At a corrobborie which I witnessed, held preparatory to marriage, the betrothed husband wore a belt from which hung in front the small apron of fringes, with a tail of black feathers dependent behind. On his head was a pointed cap about 15 inches high, in shape just like a fool's cap, formed of paperbark and covered with white down, while his face was whitened with pipeclay, and white bands ornamented his body and legs. In the ground a post had been fixed, and painted with red ochre, the representative of the dubbo-dubbo, the devil (*biráuel*), which so frequently figures in corrobbories. With this post, and with bark painted into a grotesque representation of a man, a figure was made, and surmounted with a conical cap similar to that worn by the bridegroom. The corrobborie was after the usual order, and seemingly set forth the prowess of the man, his dexterity with the spear, and skill in the chase, and I think it may be read as a challenge in which the man publicly announces his intention to take the maid. Women and children were present. On the next day there was great commotion, as a rumour of another blackfellow having declared his intention to "catch" the girl spread. At night in the camp there was a veritable babel of tongues, the women discussing the matter in all its bearings in their camp, and with their neighbours across the camps. Occasionally above the din an old lady would harangue, and now and again the headman in the Wúlnar camp, the father of Long'aba, would answer in a speech delivered from his camp 150 yards distant. It was long after midnight before the camp was quiet. Towards five on the following day the Lárrakí'a congregated near the camp, and two sides formed, armed with reed spears. In the open space between the two lines of spectators sometimes a single black would hurl his spears one after another at an opposing blackfellow, who would as adroitly avoid them, ducking his head, bending his back, or shifting slightly to one side, while sometimes seven or eight on each side would be engaged. As the spears were thrown others gathered them up, and in their turn hurled them back; occasionally, but rarely, spears were flying in both directions. Two or three were wounded, and in one the spear stood in his skull over the ear. He staggered, and the spear being pulled out, was carried into the scrub; I did not expect to see him alive again, but he was about some days after. I noticed that good humour prevailed throughout, and that the contestants appeared to be actuated more by a desire to exhibit their skill than instigated by bad blood. Muttered signs of approval, irrespective of the side, were given at any good throws or a particularly clever avoidance of the spears, and hearty applause, much laughter, and derision when there was a hit. After dusk the uproar of the preceding night was resumed, but the next day it was known that the rivals were to settle the question by a duel with clubs, he with the hardest head to win the maiden's hand. The result was adverse to the betrothed, and later, when the girl fled and was pursued by the tribe, it was by the gallant who had won her love she was captured.

In another case, when the betrothed husband desired to claim his spouse, the maid preferred single blessedness; and notwithstanding frequent solicitations during the six or seven years which have elapsed, she still remains a chaste virgin.

The boys attaining to the age of puberty are seized at dusk by men who have been watching their opportuuity, and borne away into the bush. After the news has been spread a corrobboric is held, and they are then removed to a place on the Adelaide River and taken in charge by those whose duty it is to train the youngsters in the arts and lore of their forbears. Here I was told they lived in a large wurley, which would accommodate all the boys. The boys' house of the South Sea Islands came to mind, and I have much regretted that I was unable to accept an invitation made me to accompany a boy who was taken, and see for myself what was actually the case. As a fact, besides one lad who has so far eluded capture, and a few living on the premises of their masters, no boys between fourteen and nineteen are seen at Port Darwin.

Circumcision is not practised by the Lárraki'a; it is said that it was in vogue at one time, and a reason was given for the custom falling into desuetude that the skin became too tender.

While at all times blacks are constantly coming and going at the Port Darwin camp, every year at the close of the wet season there is a general migration on a day previously fixed. They go away in good condition with sleek skins, and come back, some after a week or two, and others later, thin, rough-coated, and dirty. I do not learn that any particular rites or corrobbories are necessarily observed; even the reason for this annual migration has been always kept a close secret. In one year, 1890, I was informed that after two days' journeying the ceremony of making young men would be held, and later I heard one or two, accompanying the recital with excellent mimicry, telling my boys what had occurred. Incidentally I gathered that the young men each shouldered a heavy branch of a tree (the speaker showed the size, the small of his thigh) and marched round and round in a circle with downcast mien, their eyes fastened on the ground; then they lay prone on the earth, their faces buried in their hands; grass was placed over them to carry the flames over their bodies, and fire set to it.

The practice of taking the kidney fat obtains, and the victim in rare cases, it is said, occasionally recovers; but the idea of eating the flesh of a human being, adult or child, is an abhorrence.

Parturition is in secret. If the pangs of labour come on on the march, the woman will go aside from the track, sometimes attended by a female, while the others go on, and the woman, having been delivered, after a slight rest rejoins them; if in camp, the wurley is reserved to her accommodation. The child, born of a very light tan colour, is at the first opportunity coated with ashes.

Toothache, neuralgia, headaches, coughs and colds, and malarial fever are the usual ailments, principally confined to women and children, and on the whole there is little sickness. In syphilitic diseases the sufferer is buried in mud to the navel for several days.* Dangerous illness is ascribed to an enemy pointing a bone, or to his burning some hair or other personal belonging of the native stricken down.

At death there is woeful lamentation, beating of hands, and wailing, but the manifestations of grief are only within the family circle of the deceased—not from want of feeling, the others speak softly, mournfully, and, I may add, reverently of the deceased, but avoiding mention of his name when stating the fact. The body is sometimes placed in a tree, and sometimes buried in a sitting posture.

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* Mr. F. H. Wells also refers to this treatment as practised in the Diamantina country. *See* Reports of the Association Adv. Sci., vol. v., p. 516.

About a mile west of the Adelaide River railway station are several mounds where Awárra have been buried, and there is a Lárraki'a burying-place not far from the Port Darwin cemetery. A belief in a spiritual existence was perceptible; a happy life seemed to be associated with it, but I could gather nothing further concerning it. This was apart from any ideas originating from the teachings of the Jesuit Fathers. I was surprised to observe traces of the oriental superstition, "Evil eye."

Ceremony of Circumcision among the Aggrakúndi.—To perform the rite, Emu, the Wúlnar headman, travelled with some 200 Lárraki'a men, women, and children 125 miles to Burrundi, the journey occupying about a month; but the Lárraki'a spent a fortnight of the time at Glencoe cattle station fencing, heedless of the impatience of the Aggrakúndi. I was given to understand by Manuel, the headman of the Aggrakúndi, that the boy had been sent to the Wúlnar headman and remained in his charge, but I was unable definitely to learn when and where he was handed over; my impression is that it was at the entry upon the Aggrakúndi territory, of which the northern boundary is near Glencoe.

I was present at the ceremony, which was held near Burrundi, at a time when I happened to be at the township. Taken to the camp at sunset, I saw the boy, who was about twelve years of age, and who exhibited none of the fear that the Lárraki'a boys entertain at the first step towards being made men, seated in state under a tree, his body and face adorned with pipeclay, a white fillet encircling his head, from which hung on either side a few inches of fibre string ending in a fluffy ball, similar balls hanging from bands around the upper arm. His long rough hair was red, like his body, with ochre. A corrobborie was then held, the Lárraki'a being the performers. It took the form of a drama, and the admiration of the Aggrakúndi at the representation was unbounded. The story played was a true one, of a Lárraki'a boy of three or four years of age who had strayed along the beach and was lost. The boy (L'uérdwoa) who represented the child wandered here and there, at times lying down in very weariness, and then, although exhausted, again striving to find his people. They on their part seek him in one direction and another, and the incidents of the day are reproduced—here they see an emu, there a snake, at another place a kangaroo has crossed, until at last they find the dead body of the child. A blackfellow mimicked the appearance, the cry, and gait of the emu to perfection; the snake, for a human being, wriggled and darted wonderfully here and there as it was headed off, until it bounded into the bushes, and the kangaroo was seen hopping in the distance. The ever-present power of Evil was there, now worming himself along the ground, anon towering aloft in exultation; skurrying rapidly along, his body almost touching the earth, lying down, rolling, grovelling. While the corrobborie proceeded the women and girls, all nude, sat in a semi-circle and made the familiar music, singing the weird chant and producing an accompaniment by slapping their hands upon the thigh in admirable rhythm.

Before sunrise the next morning I was awakened by a lad, and accompanying him to the ground I found the boy upon whom the rite was to be performed was still in the same place, two or three of the men coaching and encouraging him. In a few moments Emu, Manuel, and others in full regalia approached, and the lad was catechised. The answers being satisfactory, he was borne away to a spot in the bush which had been cleared, and where eight men lay on the ground, their faces in their folded arms, head and feet alternating, the backs forming a platform. Upon the buttocks the boy was laid; black-fellows sat on the shoulders of their prostrate companions and held him, while Emu, using a piece of a glass bottle, removed the foreskin. The mother of the boy, who sat, accompanied by two or three other dames, a little removed at the lad's feet, received the portion of skin excised in the canoe-shaped water-vessel hollowed from a log, and, after washing, swallowed it. A piece of grass was placed round the penis, the skin drawn over it and bound with another bit of grass, and hot ashes applied. To aid him to preserve silence the boy had had in his mouth a tassel containing a pebble on which to set his teeth.

General Characteristics.—These aboriginals, in common with the other tribes north of the MacDonnell Range, are lighter in colour, and are destitute of the hairiness of the natives south of the range; there is little beard, moustache, or whisker, and the chest and limbs are smooth. The eyes, moreover, do not appear to me to be so deeply set, nor the racial characteristics generally so marked. The hair is fine, and in some instances very curly. When among strangers or engaged in some occupation, making a march or lying in indolence, the countenance is plain and emotionless, impassive almost to sullenness; but when the face lifts in responsive interest and friendliness it becomes pleasing and frequently very attractive; kindliness and affection lighten the heavy features, and bright honest eyes kindle and dance with mirth and joyousness. The sudden lighting up of my boy's face, as his heart responded through his eyes at some kindly remark, changed his coarse, heavy, ugly features—and the Australoid characteristics were in him most pronounced—to something very near beauty. The first time I caught this glance it was indeed a revelation to me.

Cicatrices.—The bodies of both men and women are adorned with these marks raised on the skin, but the Lárrakí'a say that no meaning is attachable to them now, and that they are merely for ornament. Formerly one on the side of the buttock is said to have represented a husband lost, and on the shoulder a brother, &c.; further inquiry is therefore desirable. I have observed three lines across the body below the lower ribs, a row of short perpendicular cuts across the chest, and three short cuts on either shoulder downwards.

Weapons, Articles, &c.—The weapons in use are spears of seven to ten feet in length, variously barbed for hunting and combat, and of two or three prongs barbed for spearing fish, as well as stone-headed for battle. There is also a light reed spear with 15 to 25 inches of stick inserted, simply pointed and hardened in the fire, in all about four or five feet in length. The wommeras are of two kinds: one a piece of flat wood, 3 feet 1 inch to 3 feet 4 inches in length, and $1\frac{3}{4}$-inch in breadth at the widest part; the other round, about $\frac{1}{2}$-inch in thickness and tapering somewhat, and a few inches longer than the flat wommera. The latter is only used for the light reed spears. The natives towards Port Essington occasionally carry a third variety, flat but curved. A sword-club is sometimes (if not always) taken into a tribal combat. At the Adelaide River it was borne, grasped in both hands, by a woman of great age, terrible in the energy which fired her. No blows were struck with it, but it seemed to be used to direct and to animate the warriors. It is of very heavy wood, and is fish-shaped. The one I possess measures $4\frac{3}{4}$ feet in length, $1\frac{1}{2}$ inches in breadth at the narrowest part to 3 inches across at 7 inches from the point to which it then curves. The bumerang is not found among them, and they are unable to make it, but they have heard of it from Queensland natives who have come over with white men; nor have they shields. The flat piece of wood, $6\frac{1}{2}$ inches in length and $1\frac{1}{2}$ inches in breadth, which attached to a piece of string and whirled round the head produces a whizzing noise, has its place in their ceremonies. Stone tomahawks and cutting instruments have gone out of use since the intercourse with the whites.

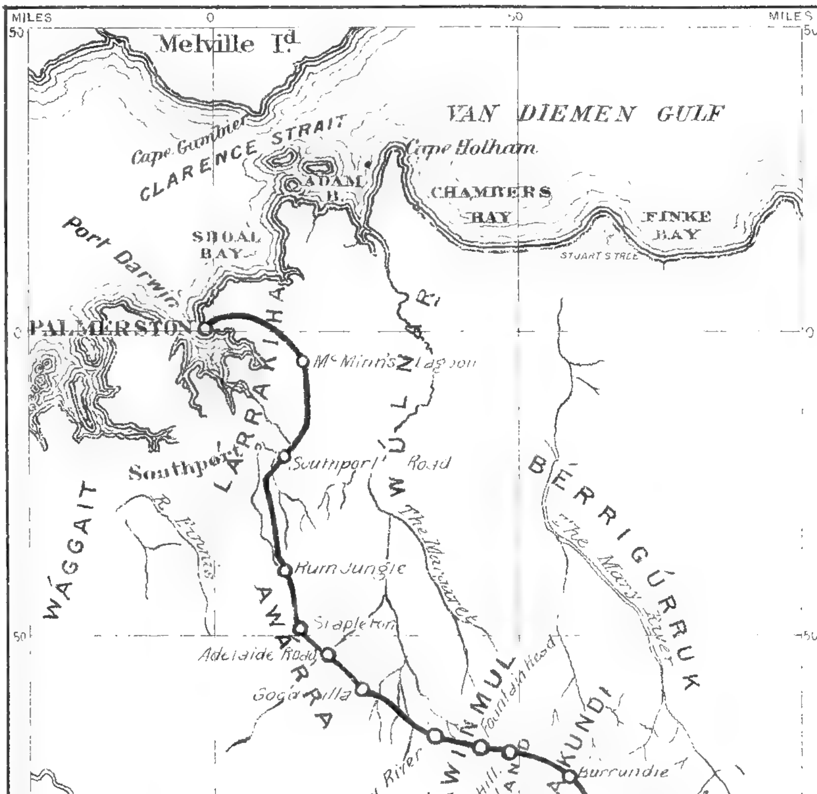
Belts of bark and of hair, and occasionally little fringe aprons a few inches in length and width, are worn by the men. The hair is often confined by a band or a fillet, and the Wulwóngga lads have at times a head-dress of kangaroo teeth embedded in gum, through which they are strung together. The young women and girls are fond of necklaces composed of bits of dry grass threaded on string, and the Wúlnar girls often wear an arrangement of twisted cord coloured with red ochre, relieved by bands of pipeclay, crossing over and under the breasts, passing under the arms, and reunited at the back. All wear neatly plaited armlets of grass. A nosepin is said to keep out the dust and to be a protection when a fever-wind is blowing. Dillybags, plaited reed baskets, and the kulamin are used, but the latter has been nearly superseded by the billycan. The string is made from fibre by rubbing it with the hand upon the thigh.

The Lárraki'a made canoes of good size hollowed out from a tree, and one was worked round from Southport to Port Darwin. Fire is kindled by a stick twirled rapidly between the hands, the point being inserted in a notch in another stick held firmly by the feet.

Smoke and Hand Signalling.—At the Adelaide meeting of the Association in 1893 a paper of much interest was read by Mr. A. T. Magarey upon "Smoke Signals," which provoked considerable correspondence in the public Press; and two facts will be of interest. In 1884 Messrs. H. Houschildt, J. Noltenius, J. Landers, and T. Schollert were murdered by blacks on the Daly River. Although I was not in the country at the time, I learnt from both whites and Lárraki'a that the latter knew from smoke signals of those murders before the former had any information, although all speed was made by the horseman conveying the news to Port Darwin.

The other instance transpired in 1890. My boy was sitting on the doorstep, and apparently *apropos* of nothing (for a boat was not expected, it being supposed that the "Guthrie" had gone past without calling) remarked, "Steamer, him come on; him sit down lame fellow," getting up and limping across the room to my table. Four days afterwards the "Guthrie" came in with a broken shaft, and I then questioned him whether he had been able to see her. He told me, No! that the boat was too far away, but "blackfellow him make 'em smoke, blackfellow been tell 'em"; and he proceeded to show me

NATIVE TRIBES OF Port Darwin



by action how the smoke was manipulated. He did not himself know the particular signals, but "blackfellow"—that is, some of the blackfellows—"him sabe."

There is a wide range, too, of hand-signalling, such as: "A dead blackfellow is here," "I have food," "Wild blacks are coming," "Where are our people?" "Come on quickly," "Go that way," &c.

8.—ABORIGINES' WATER-QUEST IN ARID AUSTRALIA.

By A. T. MAGAREY.

PREFATORY.

In gathering information as to the aborigines' water-quest in arid Australia (*i.e.*, Central) I have to acknowledge indebtedness to the works of many of our greatest explorers, and amongst other authorities to the works of Baron Sir Ferd. von Mueller, K.C.M.G., F.R.S., &c.; also Mr. Maiden's work on Australian Flora; to Thos. Brown, Esq., Nullabor Plains, South Australia; Chas. Winnecke, Esq., F.R.G.S. (explorer); Ernest Giles, Esq., Ediacara; W. H. Tietkens, F.R.G.S., Wagga Wagga, New South Wales; R. Helms, Esq., Naturalist, Elder Expl. Expn., New South Wales; Simpson Newland, Esq., Adelaide; G. W. Goyder, Esq., C.M.G., Adelaide; C. Hope Harris, Esq., Adelaide; Walter Gill, Esq., Conservator of Forests, South Australia. I have also received the testimony of experienced bushmen, and in some directions have made personal tests and experiments.

ABORIGINES' WATER-QUEST IN ARID AUSTRALIA.

"It was often a matter of wonder to me that in the height of summer, when the heated ground was shimmering under the blinding rays of the summer's sun, and

> 'When the simoom's breath was scattering death
> On all that yet could die,'

when you would think it impossible for mortals to live away from the one water, yet, away on the horizon's distance, in a country that you have visited repeatedly and know to be absolutely waterless, a column of smoke will arise! 'How can this be?' is the exclamation that escapes you. Even with the wonderful powers of endurance of the Australian aboriginal, how can he be out there and live? The half-civilised savage at your side, upon inquiry, will reply: 'He is all right; that is So-and-so (mentioning the name); he got tree-water.'"—*W. H. Tietkens, F.R.G.S.*

"The explorer is necessarily insatiable for water; no quantity can satisfy him, for he requires it always and in every place." Thus writes Ernest Giles, one of Australia's indomitable explorers.

"Doing a thirst" is a recently coined expression of bushmen in the newest gold region of Australia, and means suffering the extreme of privation and risk through lack of water whilst in the eager pursuit of gold. And to an exhausted bushman gold is infinitely less precious than water, for then water means life.

How, in such arid regions, to know where water may be found, and, with almost absolute certainty, to obtain sufficient for life-saving, is the purpose of this paper to show, as lucidly as limited space permits. The lesson is learned from our aborigines, who live, and love, and roam, and hunt, and pass away in their waterless wilds (waterless to the untaught white man).

The Australian aborigine, dwelling, as he does, in realms where water is scarce, has, through the long ages during which he has roamed his desert wilds, stored up much valuable knowledge on water supply. This knowledge has passed down from generation to generation; and having come, the white man, too, has inherited much of the treasured lore. Unfortunately, however, of this knowledge many bushmen are still ignorant, and to many ignorance has meant death.

Men in Australia have lain down under a "Water-tree," and died from thirst whilst the water they so terribly needed lay only two or three inches under the scorching sand, and beneath their outstretched finger-tips. Sad, but true! And the pity of it was they did not know that the water was there. The aborigine knows better. Trees, animals, birds, insects, and rocks, all yield up to the aboriginal of these wilds their rich secret of water supply. Of these this paper will treat in detail. Water-favoured Australia lies outside the scope of this writing. Hence what follows refers specially to arid Australia. Briefly, let us pass in review the guides to water above enumerated, but including also the aboriginal.

TREES.

The mallee, needle-bush, currajong, *Casuarina*, mulga, *Acacia*, and young growth of gum are the best of the water-trees, storing up supplies in root and stem, the root being most often the source of supply in our arid regions.

These trees grow usually in a loose, soft, dry sandy or loamy soil.

The Mallee.—The mallee scrub of our arid regions consists mostly of *Eucalyptus Dumosa*, *E. gracilis*, *E. incrassata*, *E. oleosa*, *E. microtheca*, *E. paniculata*, *E. populifolia*, and *E. uncinata*.

Of these the "Water-trees" (or "Water Mallees") are: *Eucalyptus microtheca*, *E incrassata*, *E. oleosa*, *E. paniculata*, *E. populifolia*.

Eucalyptus microtheca is so named from the extreme smallness of its fruit. Called also "Water Box." Large specimens reach 80 feet in height; stem, 4 feet diameter. Named by natives of Riverina "Tangoon"; of Murchison, Western Australia, "Callaille" or "Yathoo"; of Western Queensland, "Coolybah."

Eucalyptus incrassata.—Flowers from growth of 4 feet high; grows up to 30 feet; bark smooth, outside whitish or reddish in colour; the bark seceding, so rendering the surface smooth; seed vessel "ribbed."

Eucalyptus oleosa.—The leaves are oil-bearing; tall bushes; branched from the root; height 15 feet; bark of young tree smooth and pale. The roots of these water mallees are of incalculable value to the natives, as it is through their thorough reliableness, as yielding abundance of water for their needs, that the aborigines are enabled to go far out into arid wilds, there to roam and hunt and gather food with the utmost liberty and confidence. Seed vessel has a pistil similar to the clapper of a bell.

The roots of these water-trees run out from the stem for 40 feet to 80 feet, lying at a depth only from two inches to nine inches below the surface. They are frequently marked by a "rise" or "bulge" of soil right over the root. They are easily raised. A native goes to a water-tree, and tries the ground at from four feet to five feet from the stem; or, if guided by "bulge" or "crack," finds the root at once. If the ground is hard it is usually scooped away with his wooden shovel or scoop till the root is bared. If the soil is loose he drives his yam-stick or spear-point into the ground, and getting it under the root prizes it up, and breaks it off near the stem. Then dropping spear or stick he grasps the root with both hands, and straddling its bed, shakes, and pulls up the root to its points. Then, breaking it into lengths of 18 inches to 3 feet, he sets the pieces on end against the trunk, standing them in a coolamin or wallaby-skin bag, or in a trough formed from the bark stripped from the roots, by which bark guttering it is conducted into his water vessel. Roots of the size of a man's wrist are best. If larger the root is apt to be too woody, and the water does not flow freely.

If the hunter is very thirsty a portion of the root is broken off and the bark near one end removed, so as to give only clean wood for the mouth end. The piece of wood is then up-ended, the water flowing readily into the hunter's opened mouth, another and another piece being similarly taken, as each one is drained, till thirst is assuaged. One such mallee root will generally suffice to satisfy the wants of two or three thirsty men. For purposes of carrying, one end of such root-piece is at times plugged up with clay, and in this way water may be carried, retained in the root, for long distances. If need be, numbers of pieces of the root are placed horizontally in a coolamin and so carried, the water not flowing out so long as the pieces are in this position, but flowing when up-ended. If the water, on up-ending the root, does not spontaneously flow freely, the native hastens the process by vigorous blowing at one end. He sometimes obtains the water by shaking (as we swing a wet umbrella), when the water comes out like fine rain. The bark is generally stripped from the roots so as to give perfectly clean and pure water.

Each mallee-tree will have from four or five to seven or eight mainroots running out from the stem at a few inches depth from the surface. Trees growing in hollows between ridges will have greater abundance of water than those growing on the ridge tops.

The sap flows most freely in the hot season, when the greatest demand is made to meet the stress of rapid evaporation. In the desert of South-western Australia the explorer Eyre saw natives obtaining water from roots an inch in thickness, the surrounding soil being dust dry. (Ed. John Eyre, vol. i., pp. 349-351.)

The red mallees of the west coast always have water roots; quantity more abundant in rainy season than in summer. Gallons of water may be obtained from the roots. A man is always safe, as concerns thirst, with the red mallee about him. It is a permanent water supply. From the roots of *E. microtheca* "a quart-pot full of water was obtained in half-an-hour."

The water obtained is beautifully clear when fresh, deliciously cool, forming a most palatable and refreshing drink, free from any unpleasant taste. From the red mallee the water obtained, after standing for some hours, becomes discoloured and turbid.

The red mallee root of the west coast of South Australia is very porous, and the water gushes out at once when set on end. On the

Scotia Blocks (S.W.) of New South Wales the natives make high stacks (four feet or so) of the drained roots; why, is not evident. Natives travel from Fowler's Bay to Eucla in dry seasons through the scrub mainly dependent on mallee water. Round about Ooldea Water, S.A., Mr. Tietkens observed the same facility of dependence on water-trees. This mallee is found usually in clumps all over dry Australia, from the Darling River to the Musgrave Ranges, and from the west coast of Western Australia, through the Nullabor Plains, to the MacDonnell Ranges. Information concerning central Western Australia has not yet been obtained. It occurs frequently north of Adelaide and through the Murray Scrub east of Adelaide.

The Needle-bush (*Hakea leucoptera*: White-winged seed) is found very generally all over Australia. It is usually of the height of five to eight feet, though full-grown trees attain a height of 80 feet. The diameter of the trunk of the small variety at the base is three inches, though the trunk usually is quite short; it then forks. The wood is porous and spongy like the honeysuckle-tree.

The needle-bush is one of the best of our water-trees, the roots being water-bearing, though it does not equal in this respect the water mallee. Mr. Morton Lockhart says of it: "In an experiment on a water-yielding *Hakea*, the first root, about half-an-inch in diameter and six or eight feet long, yielded quickly, and in large drops, about a wine-glassful of really excellent water."—*Proc. R. S. Vict.*, 1860, p. 132.

The Currajong.—The currajong (order Sterculiaceæ, genus *Brachychiton*) of Central Australia is a good water-tree. It grows well in dry, arid country, and is there abundant. It is known in some parts as the bottle-tree from the shape of its stem. Evidently there are several varieties named currajong, all good water-trees. The currajong occurs in the Murrumbidgee country in North-west New South Wales; on the Paroo, the Finke, and the Cooper in Western Australia, towards Queen Victoria Spring, and through the northern regions of South Australia.

It is specially good for water storage. The tree has several large roots up to seven inches thickness at times at the trunk end. The roots are very porous, and frequently contain incredibly large supplies of water, which gushes out rapidly when the pieces of root are set on end, the roots of a tree yielding gallons in quantity. In some regions natives subsist almost wholly on this source of supply.

Desert Oak (*Casuarina Decaisneana*: She-oak class of Southern Australia).—The *Casuarina* is water-storing, both in the roots and also in cavities in the stem, the latter being, as to water conservation, one of its special peculiarities. (*See* seq. "Hollow trees.")

Referring to this oak, Mr. W. H. Tietkens writes:—"Ooldea Wate region, South Australia: Travelling once with a small native boy of about ten years of age, and towards the close of a dreadful day, the water-bag long since emptied, and the boy gasping for water and myself no better—the boy was riding a very unusually tall camel—we still had fifteen miles more to travel. All at once a cry broke from him, and with one bound he was off that camel and running towards an oak-tree—well, four chains distant at least. I stopped the camels and went up to him. He was clawing away at the hot sandy soil, and at last—snap—a root $1\frac{1}{2}$ inches thick was broken; a hard pull, and about eight feet of root was exposed, lifting the soil as it was raised. About two-feet length was broken off and up-ended into the mouth, and a cold drink the result. But not sufficient; another and another length was broken off till we had sufficient. We did not take any more than the one root, and I think there were eight or ten more such roots—enough in abundance for a dozen men. . . . The water so obtained is cool—quite cool –colourless, and refreshing; but I have noticed that upon exposure to the air for a few hours it becomes a pale-brown colour, such as would be noticed in water into which a piece of bark had dropped."

Bloodwood (*Eucalyptus terminalis*), of Central Australia.—The bloodwood is also a water-tree, several explorers referring to it in this connection.

Mr. W. H. Tietkens says of it :—"I have myself obtained nearly a bucket of water from the bloodwood-tree at the Rawlinson Range. I was cutting this tree down for smoke-house purposes, and the water was not required."

Acacia.—Several varieties of *Acacia* are referred to by explorers and bushmen as water-trees, the roots yielding a fair supply.

Trees as "Signs" of Water in Vicinity.—The beefwood. Western Australia (native name "Yarra"), L. A. Wells, Elder Exploring Expedition, p. 163; the black wattle, D. Lindsay, F.R.G.S., leader Elder Exploring Expedition, p. 29; gum-trees (large size), D. Lindsay, F.R.G.S., leader Elder Exploring Expedition, p. 39.

PLANTS.

"*The Pig-face,*" J. McD. Stuart (page 3) says, "contains a great deal of moisture, and is a first-rate thing for thirsty horses." Mr. W. P. Auld says the members of the expedition named it "squash," and states that it is a splendid thing to cure "scurvy."

Parakylia (a variety of ice-plant).—Abundant in many parts of arid Australia. It is a good source of supply for camels. Mr. D. Lindsay (Elder Exploring Expedition, p. 101) says :—"A moist plant, as good as water." The *South Australian Register* of 4th December, 1894, reports that an Afghan, who had been most dreadfully injured by his camels thirty miles west of Anna Creek Telegraph Station, had subsisted through several days of agony and terrific heat upon some Parakylia, to which he had managed to drag himself, and was saved from death through the supply of water yielded by that plant.

STEMS OF TREES AND WATER STORAGE.

The stems of several varieties of trees, when not too old, yield good and sufficient supplies of water for life-saving. Young gums, stringy-barks, and varieties of mallee are all so used by the aborigines.

The young tree is broken or cut off, the top removed, then the root end is set uppermost. In from ten to twenty minutes from several such stems a quantity of water sufficient for life preservation may be obtained in coolamin, billy-can, or other vessel. The statement holds good with qualification as to locality, but a bushman might always make the experiment of in this way trying for water before giving up hope and abandoning himself to despair.

The water obtained is clear, cool, palatable, and refreshing.

HOLLOWS IN TREES.

A highly valued source of water supply to aborigines is in the storage of water in the hollows of trees. Natives are enabled to make long stages through otherwise waterless areas by this means. Such water storages occur far and wide all over Australia.

The desert oak (*Casuarina Decaisneana*) more frequently than any other is the tree in the cavities of which such supply is found. In the fork of the tree there frequently exists a cavity of larger or smaller capacity, with a very small orifice usually. The rain-water runs trickling down the limbs of the tree to the fork, and, some finding its way through the opening, gradually the cavity is filled, and hence the natives' supply. These hollow trees are as well known to the aborigines of the region as are their native wells and rock-holes. They are pointed out to friends and to whites. The water stored is cool and pleasant. Being inaccessible to birds and animals, the water is fresh and clear. Sometimes there may be even two or three such cavities in one tree. It may be reached from the ground, or it may be necessary to climb high into the tree for a drink. It may be a cavity between the inner and outer shell of the trunk, or the carefully lined hollow of some borer of wood. Sometimes the water is stored in cavities of decayed trees, or in "spouts" of dead limbs. Mr. David Lindsay (Elder Exploration Expedition, p. 129) describes a lubra in Western Australia discovering such a stock of water in the forked limb of a tree growing on the verge of a salt lake, her attention being drawn to the tree by a moving rush of small ants, the creatures rushing in and out of a hole in the fork. On testing the cavity with a dry stick, and on withdrawal, finding its end wet, she went to a near bush; breaking therefrom several twigs and loosening the bark with her teeth, she withdrew the wood of the twigs, leaving the tube of bark. Fitting several such tubes together, she formed a pipe, which, being inserted into the cavity, enabled her to suck up the water and drink. The natives also used hollow stems of grass or hollow reeds for the purpose. A bunch or ball of dry grass is fixed to the point of a spear and thrust into the water store. On withdrawal the water is squeezed out into a vessel, and the process is repeated till sufficient is obtained. This last operation was seen at a cavity in a *Murn* or mallee-oak, and is described by Mr. John Cairns (Transactions of the Philosophical Institute of Victoria, 1858, iii., p. 32). Such reservoirs of water are used by the natives year after year, and often become very widely known. They are a very well-known feature in the Nullabor Plains country. The tree is usually known as a "Box," of which there are several varieties, according to locality. Having thus hastily reviewed the aborigines' forest lore in water-quest, the aid obtained from animal life will next be noticed.

ANIMALS

Kangaroo, Wallaby, and Dingo.—There is some controversy as to the true value of animals as indicating nearness of water in dry country. The truth seems to be that, whilst at times they are good as indicators, they are at other times untrustworthy and unreliable. The animals named seem to be able to travel very long distances into arid country, and to subsist for several days at least upon the food eaten. Under such conditions even quite fresh tracks might lure a thirst-stricken bushman to death, should he follow them up too long. Their tracks have often been seen several days' journey away from any known water, in well-known country.

In very dry seasons the dingo will travel long distances over many miles to water. For example, they have been known to travel from the interior country down to the "Great Bight" (West. So. Aust.), where, on the sea-coast, they will scratch the sand with their feet, and so dig down to water. They do the same thing in the creeks in the interior.

BIRDS.

As thoroughly reliable guides to waters in very dry regions there is no rival to the birds, some of which might be named "Water Finders."

The Diamond Birds—known variously as "Diamond Sparrow," "Zebra Finch," "Chestnut-eared Finch" (*Amadina castanotes*), "Spotted Pardalote" (*Pardalotus punctatus*)—are of birds, *par excellence*, the "Water Finders" of the dry regions of Australia.

Stuart (explorer) says:—"And at eight miles [on the Hugh] our eyes and ears were delighted with the sight and sound of numerous diamond birds, a sure sign of the proximity of water." All the foremost explorers are agreed as to this sign. The presence of flocks of zebra finches is one infallible indication in the dry country of the nearness of water. Little or much, hundreds of gallons or a teacupful, water is there; for water these pretty little twitterers must have, and they must have it often. Any apparent exceptions are probably due either to the oversight or hurry of the traveller rather than to any fallibility as to the bird as an indicator of water.

So docile are these little fellows (diamond birds) that they will sit upon the bare skin of an aboriginal whilst he bends to his work digging out a hole in the sand with his wooden scoop for water, and they seem to be in no way disconcerted when he throws the sand over his shoulder, where they are perched, as he works. Nor does the native resent the presence or familiarity of his saucy little feathered companion. He wants water, and they wait to drink with him.

After travelling through miles of the silent bush, should the traveller come upon a small flock of these birds, he may know infallibly that a supply of water is near by; and alert, intelligent watching will soon enable him to find it. The bird nests in root-holes, in the banks of creeks, and waterholes, and is abundant wherever water is available.

The Pigeon.—Next to the above, in its Australian varieties the pigeon ranks high as a "Water Finder."

The "Crested Dove," "Wire-Wing Dove" or top-knot pigeon (*Ocyphaps Lophotes*), the "Bronze-Wing Pigeon" (*Peristera Chalcoptera*), "Flock Pigeon," "Rock Pigeon" (*Petrophason*, Gould), all come under this section. The pigeon is found all over Australia, and is *always* within reach of water. It feeds on grains and seeds. It flies out over the plains to feed in the day-time, and flies in again to the water at sundown. At this time of the day they may be seen, in parts, in countless flocks gathering in to the waters. They fly very swiftly towards water, and the pigeon usually alights some ten yards away. It waits awhile, and then walks quietly to the water and drinks. It drinks very copiously, so much so that often it is a trouble to it to rise from the ground. Flight away from water is heavy and slow. An alert observer can judge by the style of flight whether the pigeon is going to water or from it. It does not go in to drink during the heat of the day.

Speaking of the "Rock Pigeon" Leichhardt writes—"They live in pairs and small flocks. They fly out of the shade of overhanging rocks, or from the moist wells of the natives, around which they cluster like flies round a drop of syrup." Careful note of the flight of the pigeon will tell an ordinarily intelligent observer which way to seek for water.

Stuart says—"I observed very large flocks of pigeons coming in clouds from the plains, in every direction, towards the ponds. Some time afterwards we saw them coming back, and flying away into the plains as far as the eye can reach, apparently to feed."

Cockatoo.—The "Corella" cockatoo (*Cacatua gymnopis*) (white, crestless), galar parrots (*Cacatua eos*), "Rose-breasted Cockatoos," parrots, and parakeets are all good indicators of water, the first two being considered specially valuable in this regard; also the "Sulphur-crested Cockatoo" (*Cacatua galerita*, Gould).

Crows, "Kite-Hawks," Soaring Eagles at times indicate water, but are at other times seen far away, and must be deemed unreliable.

Emu (*Dromanius*) and "*Laughing Jackass*" (*Dacelo gigantea*) (South Australian native name "Kooyana") are both unreliable as "Water Finders," since, like the dingo and kangaroo, they may be seen very far from water, subsisting upon the moisture supplied in the food eaten. In this respect these all greatly resemble the camel.

Geese flying low are a sign of near water, and are seen at times in very dry country, but with water in the vicinity.—*Leichhardt*, p. 508.

Absence of Birds.—Stuart, pp. 285-291, says—"We have met no birds that frequent country where water is. . . . The absence of birds proclaims it [Sturt Plains] to be destitute of water." This would refer to waters accessible to birds. There might be root or hollow-tree water available to the traveller.

Insects.—Some forms of insect life are useful, and reliable indicators of the presence of water.

Large and *Small Red Hornets* and the *Mason Fly* (like a long-legged wasp, really a hornet) point to water. Ernest Giles (vol. i., p. 95) speaks of the hornets, along with diamond birds, gathering in swarms round the searcher for water, as, with his scoop, he sinks a hole into the sand of a creek-bed to obtain the precious supply. The long-legged wasp, with legs drooping down, is seen in dry regions hovering steadily over a special spot. An observer under these conditions, upon dismounting from his horse, found, upon close examination and test, that the soil at the spot was quite moist, and scratching or digging down would there secure more or less of a supply of water.

Mussell Shell.—The natives consume these, wherever found, in great quantities. The presence of heaps of shells beside water indicates the permanence of the supply. Stuart says, p. 113 (Louden Springs)—"Round about their fires were large quantities of shells of the fresh-water mussell, the fish from which they [natives] had been eating. I should think this a good proof of the water being permanent." Stuart is in error; shells are found alive in holes that have been dry three or four years.

Water Frog.—Like the camel, when "topped up" by his Arab master for a long journey, the "Water Frog" of Central Australia gorges himself quite full of water, against a dry season, whilst the water is still about him. He then buries himself deep down in the soft mud at the bottom of his watery abode—the mud dries up, and becomes thoroughly caked all round him. Thus he solstitiates until the next rainy season comes round again and releases him.—*Horn Scientific Exploring Expedition.*

DEW.

The aboriginal has learned to avail himself of every possible source of supply of water in his fight for existence in ungenerous country. He knows that in certain regions a special desirable form of food supply may be enjoyed, if only he can also have water whilst roaming through that hunting-ground. Amongst such sources of supply he avails himself freely in parts of the water-store afforded by "the gentle dew." The sweet, cool Aurora, with tender compassion for the dusky wanderer, hangs on grass and reed and shrub the day's store of grateful water in the sparkling drops of clear fresh dew, which the eager native gathers into his spacious coolamin. Going abroad before the sunrise, he gathers with sweep of arm or tap of stick the hanging dew-drops for his frugal supply. Sometimes a handful of soft dry grass, pressed into a ball-shape, is swept as a sponge over the dew-laden grass, and its gathered store squeezed into his vessel; or the catching utensil is held close under the dew-laden twigs of tree or shrub, and a gentle tap rains the drops down for his store. In the western regions of Australia, along the great southern coast, bark vessels are much used for water-bearing. The sandalwood-tree is specially useful as a dew-bearing tree, yielding a wonderful supply of this dew-water from its leaves. Quite a good drink may be be obtained from it with a suitable catchment vessel.

Ed. John Eyre (vol. i., p. 361) states that he gathered thus a quart of water in an hour in these regions from spangles of dew hanging on grass and shrub.

Thos. Brown, Esq., of Nullabor Plains (S.A.), narrates that a black lad came to him when twenty miles out in the scrub belt, and gave him to understand that he (the boy) had come in from a point from whence it was only possible to have come by traversing *en route* an absolutely waterless belt of country. The lad said further that two gins and a picanniny were also coming after him across the plains, and would come in the following day. The lad then joined the station blacks' camp. Marvelling at the episode, Mr. Brown inquired from the other blacks how the strange blacks got water for their journey across the plains. Their reply was, "Get water off the grass" (or, perhaps, shook the bushes).

There are very heavy dews along the Australian Bight coastline, and at times these extend far back into the scrub belts. Both kangaroo and dingo obtain water for their needs in these same regions by running through the dew-laden grass with their tongues hanging out, lapping in the moisture so gathered as they move. Bushmen may learn a very useful lesson here which might prove of service in case of need.

NATIVE WATER CONSERVATION.

The Australian native has not hitherto been given all the credit which is his due as regards making provision for future needs. Though, perhaps, generally thriftless and shiftless as respects water conservation, he is not so much so as his detractors represent. In regions where rainfall is slight and storage precarious the native has supplied for himself storage after his own fashion. One such form is seen in his "rock-hole." Generally these water tanks are natural reservoirs, at times they are artificial. The native commences the construction of a new storage chamber by pounding upon the level surface of a rock face, constituting a catchment area. He places or allows surface water to lie in the slight cavity he has made. The pounding is afterwards renewed upon the water-softened rock—the process being regularly repeated until a cavity with a capacity of a few (two or three) up to hundreds of gallons is hollowed out. These rock-holes are often enlarged below, and some of these tanks will hold 600 or 800 gallons of water. These they protect from pollution of animals or stealth of wild dogs by filling the mouth, or at times the entire cavity, with sticks or stones. Such rock-holes are found all over Central and Western Australia, proving often a godsend to the famished explorer and his suffering animals.

NATIVE WELLS.

These are sunk in soil or sand, and usually contain only a meagre supply. They are frequently hidden under the cover of a bush, or in the midst of a thicket, being then easily "missed" by the thirsty seeker. Warburton says of these wells that they are sunk with a slight curve in the down course, the water being thus shielded from the direct rays of the burning sun, thereby ensuring less evaporation, and the contained water is also kept cool. Here is evidence of foresight and wise skill on the part of the aboriginal conservators of water. Native wells often are enlarged in capacity at depth, are sometimes serpentine in the course down to water, and vary from 2 feet or 3 feet to 15 feet or 20 feet in depth. It is most difficult in some cases to reach the water at all; and at times the water contained is so terribly fouled by dead reptiles, birds, and rubbish that even a water-famished horse has refused to touch it.

NATIVE DAMS.

Dams of natives' construction, for the purpose of conserving water, have been seldom met with. Ernest Giles ("Australia Twice Traversed," vol. ii., p. 93), at Pylebung, near Youldeh, West South Australia, described a crescent-shaped aborigines' dam formed of clay, thrown up by native wooden scoops from the bed of the catchment space. It was five feet thick at the base, two feet thick at the top, five feet in height, some 20 yards long, and the opening was to the south—a unique specimen of engineering skill, for which skill they get no credit. The Boundary Dam of Giles is another instance.

The lamented Leichhardt (Journal, p. 405) describes a dam so placed as to arrest a soakage of fresh water oozing from beneath the bank of the Robinson before the flow could reach the salt water of the river. The retaining wall of the dam was formed of clay.

SCRATCHING AND SINKING FOR WATER.

Frequently there is water at comparatively slight distances below the surface of the sandy bed of surface-dry rivers and creeks, no sign of such water being noted in the bed. Natives, dingoes, emus, explorers, cattle, and horses all have learned this in Central Australia's wilds, and in this way, by scratching, digging, or pawing, they obtain supplies. Fresh water is often found in the sand of the sea-shore on the southern coast of Australia ; and in the Port Lincoln district, near where Flinders first secured water, it is found spouting up out of sand-covered rock, so far below high-water mark as at every returning tide to be covered by the sea.

NATIVES.

The presence of natives is an indication to whites and "strange" natives of the proximity of water in some of the forms referred to. Signal and camp smokes are always an indication of natives and water, though the natives may be difficult to find, as they travel quickly and hide, if wild and in fear.

WATER-POISONING.

At times natives "doctor" or poison some supplies of water, specially those to which emus resort to drink ; their purpose is to stupefy the game thereby, that it may be more readily captured. A variety of "Nightshade," locally known on the Paroo as "Native Myrtle," is there used for this purpose. In places in Central Australia the native tobacco (*Pituri*) is similarly used. In the Northern Territory the inner bark of a tree is used, but particulars are not yet available. Leichhardt speaks of waters accidentally rendered poisonous through having (in ignorance of their properties) the seeds of a variety of *Acacia* soaked in them.

WATER-CARRYING.

Natives carry water for domestic use in vessels when they wish to camp at a distance from water supply for the purpose of hunting or seed or root gathering. The coolamin, a vessel hollowed out of wood, is in most general use. Another vessel seen was a hollow log some 15 inches in length, with one end "stopped" with string, rubbish, and clay. An observer noted a vessel (north-west of the lakes in South Australia) in which water was being carried, which was taken to be made of dingo skin, having only one opening, and having the hair side inwards. Skins of kangaroos, of large wallabies, and of opossums seem to have been in general use. In the Northern Territory an unusually large vessel, like a coffin in shape, six or seven feet long, hollowed out like a canoe, borne by two men, was seen in use for water-carrying. It was made of beanwood. Lubras (Charlotte Waters, South Australia), when carrying their coolamin filled with water, use a rope of fur or hair wound into a ring and placed on the top of the head ; the coolamin resting safely in the cup or hollow formed by the ring of rope, enabling the bearer to walk erect, at the same time giving free use of the hands for other purposes. A coolamin of average size was found on test to have a holding capacity of some two gallons. A hollow root of old mulga has been seen in use for water-carrying, but this is not usual. Mallee-roots, with one end stopped with clay, for water-carrying, have been already noted.

INTRODUCING WATER-TREES.

It would form a fair field for inquiry whether some of the known water-trees of other countries might not be introduced into Australia for purposes of life rescue for bushmen in cases of water famine. It may, too, be possible to extend the area of country for growth of our own "water-trees," by sowing their seeds in waterless regions, so affording a wider supply for Australia's hardy bushmen.

CONCLUSION.

Having taken this cursive glance at the water-quest of the aborigines of arid Australia, it will be well to note in what way their water craft may be made of benefit to explorers and bushmen whose calling takes them into those regions of water famine. The bushman should make himself well acquainted with—

First, the Water-trees—Water mallees, needle-bush, currajong, bloodwood, desert oak, and *Acacia;* and when in distress he may go confidently to their roots for water supply.

Secondly.—The presence of diamond bird, finch, pigeon, cockatoo, parrot, and hornet should be looked for, and when seen made use of. Water is then very near.

Thirdly.—If none of the above present themselves, let him try scratching in the sandy bed of creeks for water, as taught by the native, the emu, and the dingo.

By resort to some one of these methods the desert would many times be robbed of half its terrors, and the unknown "found dead" would less often figure in those lists of lost bushmen published by our Australian authorities. The term "Aquafera" might with advantage be added to the names of our special "Water-trees."

The children of Australia should in our schools be taught to know these trees wherever seen—an easy botanical lesson. Let this be done, and the present brief survey of our natives' water-quest will have been taken to good purpose; and the white Australian may traverse the dry realm of "arid" Australia with all the confidence of his dusky brother, the Australian aborigine, who is now hovering on the horizon of an early extinction, leaving us, as one permanent memento of his existence, his legacy of lore in water-quest.

9.—ROTUMAH.

By Rev. THOMAS MOORE.

10.—A COMPARATIVE VIEW OF SOME SAMOAN CUSTOMS.

By Rev. J. B. STAIR.

SECTION G.

ECONOMIC SCIENCE.

1.—A PLEA FOR THE STUDY OF THE UNCONSCIOUS VITAL PROCESSES IN THE LIFE OF COMMUNITIES.

By Sir SAMUEL W. GRIFFITH, G.C.M.G., M.A., Chief Justice of Queensland.

It has often been complained that modern scientific methods have not been sufficiently applied in the study of political economy, but that the subject has been treated too much as if it were a branch of ethics or metaphysics capable of complete development by deductive argument from abstract propositions assumed *a priori*, instead of being regarded as a science which should be founded on careful and minute study of the actual phenomena of social life. Whether it be an actual objective fact, or only a pretty conceit, that a nation or community is a real and distinct entity, with physical and mental attributes of its own—the individual member bearing to the whole a material relation analogous to that of a cell to an animal—there is no doubt that there are many striking points of resemblance between an individual and a body politic. A community may grow, enjoy robust health, become stationary, decay and perish. One portion may apparently be in the enjoyment of health while another portion suffers from defective nutrition or its energies are paralysed. For the most part the vital processes of a community—that is, the processes by which the means of maintaining bodily life are provided, distributed, and assimilated—are, like the vital processes of the individual, performed automatically and unconsciously. It is true that if you pay attention you can notice that you are breathing, and that your heart is beating. It is true that you can increase or diminish the frequency of the action of your heart or lungs, but as a rule the process is as automatic as that of digestion or circulation. So in the body politic, although every separate act in the vital processes is performed by an intelligent being, and may be done differently if he chooses, yet the general movement is, to a great extent, automatic and unconscious.

A physician called in to treat a case of disease in the individual begins by diagnosis, and endeavours to discover the seat of the cause of the disorder. But before the practice of anatomy and the discovery of the circulation of the blood the reasoning of the physician was to a great extent *a priori*. The health of communities—the wealth of nations—depends upon obedience to the laws of health as much as that of individuals. The science of political economy should be to communities what the science of medicine is to individuals. The statesman should be the *medicus reipublicæ*, knowing the laws of national health, and capable of diagnosing the causes of disorder and of prescribing the appropriate remedy. But this capacity can only, I think, be attained by the patient application of the same scientific methods of investigation of phenomena that have in the case of other sciences led to such remarkable results during the present century. It may be as well to remark at this point that this paper deals only with objective material facts. That the study of such facts will not account for all the vital phenomena of a community is true and obvious. Nor does a knowledge of the processes of digestion and circulation account for all the vital phenomena of a man. But it would be as reasonable to object to a study of the unconscious vital processes in a man on the ground that "life is more than meat" as to object to the study of the physical phenomena of social life on the ground that it takes no note of the mental attributes of men. I make this observation to avoid the charge of forgetting that the effects which we see around us are the resultant of a hundred causes, and that the discovery of one of them is not a solution of the enigmas of life. Nevertheless, since the various material phenomena of the life of a community are the effects of material causes, the study of the phenomena is the most likely way to discover those causes.

The bodily health of the individual, apart from his surroundings, depends upon the supply of a sufficient quantity of suitable food, upon the proper digestion of that food, and upon the due circulation of the blood which is the product of digestion. If the individual has not attained maturity, this product must be sufficient not only to repair waste, but to supply the additional material necessary for growth. If the food is insufficient or unsuitable, if the digestive functions are deranged, or if the circulation is out of order, the health of the individual suffers. So in a community. The first condition of health is a sufficient supply of proper food for its members. In the existing state of societies clothing and shelter may be regarded as equally essential. These three terms, food, clothing, and shelter, comprise all the ordinary articles of consumption of the members of a community, whether the food is simple or luxurious, whether the clothing is limited to a loin cloth or includes the richest jewels, and whether the shelter is a hut or a palace. Warlike stores are another class of articles for which provision must usually be made, but which it is not necessary for my present purpose to consider further.

The fund which supplies this food, clothing, and shelter is the income or revenue of the community, and corresponds to food in the case of the individual. (This revenue is not to be confused with the product of State charges and levies, which is called the State revenue.) This fund, having been brought into suitable form, is circulated or distributed throughout the body politic. Part of it is consumed in repairing waste, and the remainder is available for growth, or for additions to the capital or stock of the community. If there is no surplus there can be no growth in the wealth of the community. If the revenue is insufficient to repair waste, the community, or some part of it, will be insufficiently nourished; and if, although the revenue is sufficient, the circulation of it is defective, the same result will follow as to the part where the circulation is obstructed.

It is necessary, then, in order to a proper knowledge of the material condition of a body politic, to investigate its sources of income (or food), both as to quantity and quality, the manner in which this income or a sufficient part of it is digested—that is, brought into the form in which it can be made available for consumption as food, clothing, and shelter—and the manner in which it is circulated through, the community to perform the functions of repairing waste and providing for growth.

1. As to the source of revenue. "The annual labour of every nation is the fund which originally supplies it with all the necessaries and conveniences of life which it annually consumes, and which consists always either in the immediate produce of that labour or in what is purchased with that produce from other nations"—("Wealth of Nations," opening sentence). The ultimate source, therefore, of the income or revenue of every community is the application of human labour to the gifts of Nature, whether those gifts are organic or inorganic, animal, vegetable, or mineral. The term "immediate produce" in the passage just cited includes of course the results of all labour applied to any object by means of which an additional value is added to it up to the time of its passing into actual consumption within the community, or of its being applied in exchange for the produce of other nations.

The fault in the agricultural or physiocratic system of political economy, which represented the produce of land as the sole source of the revenue and wealth of every country, was that it denied that the labour of artificers and manufacturers applied to the rude products of the earth added anything to the whole annual amount of the produce. Such labour was therefore considered unproductive. Adam Smith refutes this notion at some length (Book IV., chap. ix.) The circumstance that the notion was quite inconsistent with observed facts was probably sufficient to account for the neglect of this system. The fallacy of the notion is apparent as soon as it is recognised that the products of the earth are not for the most part destined to be immediately consumed in their rude state by the persons whose labour produces them. So far as they are destined to be exchanged for other products it is plain that all labour applied to them which results in their being exchangeable for a larger quantity of such other products than if it were not applied increases their value for the purpose of exchange. And, as the things obtained in exchange are intended for the purposes of consumption, the result is the same as if the labour applied to the rude products had been applied to the production of the things obtained in exchange. The consequence to the community has been that by reason of the labour of the artificer consumable articles of greater value have come into its possession than would have come if he had not done the work. His labour is therefore productive. Apart from this defect the agricultural system seems to have been founded upon the only sure basis, and it is to be regretted that its doctrines have been so much neglected.

It cannot be too often or too emphatically repeated that the only permanent source of the income of a community is the labour of its people applied to the gifts of nature. There are, it is true, two other possible sources—loans from other communities, and receipts of individual members of the community from investments made abroad. In considering the state of a community at any particular time regard must, of course, be had to these other sources of income. But neither can be treated as normal. They may therefore be disregarded for the present purpose. I wish that this fundamental and axiomatic principle could be impressed upon the minds of children in every school in the country. It would save much sorrow if men always remembered it.

2. The quantity of income. The total income of a community is equal to that of all its individual members, and the total income of all the members is equal to that of the community and no more. However elementary this proposition may appear, it is continually disregarded. For instance, in statistics as to the income of a community, it is common to find that so many persons are put down as receiving incomes of £5,000 and upwards, so many more of £1,000 to £5,000, so many more of £500 to £1,000, and so on. Then the sums of these incomes are added together, giving a total which is taken to be the income of the community, and from which the average income of the individual members is calculated, although the total exceeds enormously any possible estimate of the value of the annual produce of the labour of the community. The explanation is, of course, that the same sum is reckoned two or three times—perhaps ten times—over, sums paid by one person out of his income being reckoned also as part of the incomes of the persons to whom they are paid.

The importance, for the purpose of ascertaining the real material condition of a community, of knowing what is its income—that is, what it has to live on—is so great that it may warrant a moment's digression for the purpose of illustration. It has often been observed that many of the elementary principles governing human society may be investigated with advantage in the simplest forms of society. Allowance must be made for other disturbing causes that operate in more complex organisations, but the observation is certainly true with regard to physical laws which prevail *semper et ubique* as inexorably as the laws of numbers. A man left alone on a desert island must provide himself with food or starve. Two men similarly placed must collectively do likewise. In this case, however, one may, if he can, provide food for both. It is equally true that a community occupying a country must provide itself with food or perish. If it provides food enough for some only of its members, the rest will perish. The food produced must be sufficient for the whole community. Take the case of a tribe, like some of those in New Guinea, who cultivate the land and catch fish, but have no dealings with their neighbours. The income of the tribe consists, as in the case of the solitary inhabitants of the desert island, of what they can get by the application of their labour to the bounties of Nature. No amount of barter or exchange of the products of one garden for those of another will increase the total quantity. Suppose now that one of the tribe, who is called a chief, produces nothing himself, but levies a tax of half the produce of their labour from all the other members of the tribe. Suppose further that he distributes three-fourths of the produce of the tax by way of bounty amongst his sub-chiefs and personal retainers; and that they in turn distribute one-third of their share amongst others. The sum of the incomes of all the members of the tribe is then double the total quantity of the produce of the tribal labour. For let that produce be represented by the number 200. That number will represent also the primary income of all the producers. The chief has an income represented by 100, his sub-chiefs and retainers an increased income represented by 75, and their dependents an increased income represented by 25. The total is 400. But the actual income of the tribe available for their sustenance remains 200 and no more. If the tribe instead of consuming the whole of the produce of its labour in its own support engages in external trade and exchanges some of the produce for other articles of more value to the tribe, there may be an increase in the income of the tribe to the extent by which the value of the articles received exceeds the value of the articles given in exchange. But the whole income of the tribe comes, as before, exclusively from the produce of its own labour, although it no longer all goes into consumption in its original form. If, now, some primitive arts or manufactures are practised, by which an additional exchange value is given to the primary products, so that an additional quantity of consumable articles may be acquired in exchange for them, this added value will produce an increase to the tribal income to a corresponding extent. But, whatever the extent of the added value, or the nature of the additional work, the total value is still the product of the labour of the community. These conclusions are equally true with respect to the most barbarous tribe and the most highly civilised nation, but I am disposed to think that the extent of their practical acceptance as a rule of life varies in inverse proportion to the degree of civilisation. The only way to increase the income of a community (apart from the revenue coming from foreign investments and apart from borrowing or stealing) is to increase the quantity of the produce of its labour, which can be done only by increasing either the number of producers or the efficiency of their labour.

For the purpose of estimating the income of a community—that is, its supply of things available for consumption in the form of food, clothing, and shelter, and for increase—the value of the produce of the labour of the community must, in the case of articles which pass into actual consumption within the community, be taken at the moment when they are consumed. In the case of products exported in payment for other articles the value must be taken at the moment of export. An additional value may, it is true, be given to the articles imported by the application to them of labour before they in their turn pass into consumption, and this will be an addition to the income of the community, attributable, however, to the period following the importation.

The fact that in existing civilised societies the exchange of goods is not conducted by barter, but by sale for money, or on credit, makes no difference. Gold and silver come into existence in a portable form as the result of the application of human labour to the gifts of Nature, in the same way as any other article of use or value. Coin may sometimes be treated as such an article. But, considered as money, coin is a mere medium of exchange, and adds nothing to the quantity of the things exchanged by means of it, any more than a water-pipe adds to the quantity of water that passes through it. The real subject matter of exchange is the produce of labour. We are thus led to the consideration of that process in the body politic which is analogous to digestion in the animal, and by which the products of labour are brought into the form in which they can pass into consumption and perform their function of repairing waste and providing for growth and accumulation. It is evident that this process, which is for the most part unconscious, must be such that, as a result of it, the products are made exchangeable for the food, clothing, and shelter required for consumption by the individual members of the community and for increase. It includes carriage, manufacture, and distribution. It is obvious that the process may be well or ill done, wastefully or economically; that a process suitable for one time or place may be unsuitable for another, and that any disturbance or ill-adjustment of the mechanism by which the process is performed may give rise to serious disorders in the health of the body politic. This part of the process, may, however, be conveniently further considered in connection with that of circulation.

Before passing to that branch of the subject it may be worth while to point out that in many communities, notably those which have large foreign obligations, part of the income of the community is not available for the supply of food, clothing, and shelter, or for growth and accumulation. Deductions must be made for payments to foreign creditors as well as to absentee owners of bounties of Nature situated within the community. If the total income should be insufficient to supply the necessaries of life and to discharge their obligations, the community must have recourse to further borrowing or make default. The burden of the obligations is in any case an effective diminution of the income of the community available for food, clothing, and shelter, and for growth and accumulation.

What is the annual income of the body politic of Queensland or of any other Australian province, or, for that matter, of any other country, and how much of it is available for itself after discharging its foreign obligations? What is the total amount available annually for the supply of food, clothing, and shelter to the people, and what surplus is left for growth? An answer to these questions would show at once whether a country was progressing or retrogressing in material prosperity. And without an answer to them, and without the inquiries that are necessary to afford an answer, how can the true condition of a community be ascertained with any degree of accuracy?

I have not myself seen any comparative statistics dealing with this aspect of the wealth of communities. In the case of older nations the difficulties in the way of accurately ascertaining the facts would probably be considerable, but in the case of communities like those of Australia they should be trifling as compared with those of preparing, say, the remarkable statistics lately published by Mr. Coghlan on the movements of money in Australia. Besides the knowledge of the actual condition of the community, which I conceive to be highly important, if not essential, to its welfare, and which might be acquired by the investigations I have suggested, some other interesting facts would be disclosed—for instance, the proportion of the annual produce that is disposed of in discharge of foreign obligations and for no present equivalent, the proportion of the whole income of the community that is taken by the State to defray the cost of government, the actual burden of an income tax or a property tax, and—which I anticipate would be the most surprising of all—the average amount annually expended upon the food, clothing, and shelter of each individual.

3. The quality of the income. On this point it is sufficient to remark that the products of the labour of the community must be such as to be themselves available for consumption in the form of

food, clothing, and shelter, and for increase, or else must be such that they can be profitably exchanged for the products of other countries which will be available for those purposes.

4. Circulation in the body politic. It remains to consider the process, corresponding to the circulation of blood in the animal frame, by which the produce of the labour of the community is distributed in the form of food, clothing, and shelter to the several members of the community. I have already observed that, although every act in this process is done consciously by an intelligent person, the process considered as a whole is as automatic and unconscious as the work of bees in a hive, the individual actors looking only to the immediate result of their work. What are the actual phenomena of this circulation and the laws that govern them?

This circulation must not be confounded with the circulation of money, which is quite a different thing. If we bear in mind that the real subject matter of the circulatory process consists, not of money, but of the products of the labour of the community or the things for which they have been exchanged, it will not be misleading, and it may be convenient for the present purpose, to treat the money which is used as the medium of circulation as identical with the things which it represents.

We start then with a certain sum representing the annual produce of the labour of the community, and from which all expenses of the maintenance of all its members, productive and unproductive, and including the cost of government, are to be defrayed. If this fund is sufficient for its purpose, and if the process of circulation or distribution is effective, every member of the community should be supplied with a sufficiency of food, clothing, and shelter, and there should be something to spare for growth and accumulation. If, however, although the fund is sufficient, the process of circulation is ineffective, we may expect to find some parts of the body politic in a state of congestion or atrophy. It may, I think, be asserted with some confidence that this flow of circulation is governed by definite laws. Probably it takes place along the lines of least resistance. Probably there is in every healthy community a normal flow. The actual flow is certainly capable of being observed and investigated, and the laws governing it are probably open to discovery. I am not aware of any investigation of the subject from this point of view since the once celebrated *Tableau Economique* of Quesnay, the chief of the Physiocrats, which obtained such unbounded praise from the elder Mirabeau. The *Tableau* appears, however, to be lost, and I have not been able to meet with either of the books in which it was described in some detail. The course of circulation may vary according to the sources of the part of the fund from which it is specially derived. The sources of the income of communities certainly differ according to their local situation and circumstances, and the course of the flow of circulation will require separate investigation accordingly. The income of an Australian community is derived mainly from pastoral, agricultural, and mining industry, transport, and manufacture. The income of an individual is that part of the annual produce of the community which falls to his control for the purposes of consumption. In the case of persons who receive salaries or wages, or whose income is derived from investments, the whole income is practically at their own control for the purpose of consumption. In the case of persons who are engaged in the work of manufacture or distribution, the gross income much exceeds the net amount available for immediate consumption under their own control. The difference is important, but I do not stop to pursue it. Take the case of the products of pastoral industry. A comparatively small part of them passes into immediate consumption in the form of food for the persons engaged in the industry. The greater portion, having had additional value conferred upon it by the work of preparation and transport, is exchanged for other articles destined for immediate consumption, the exchange being made either within the community—in which case the pastoral product itself passes into direct consumption—or by means of export, in which case the articles received in exchange go into local consumption. In the case of mines, again, only a small part of the rude produce—in the case of gold and silver practically none—passes into consumption amongst the persons engaged in the industry. The rest is exchanged for other articles which are consumed, as far as needed, in the support of those persons. None of the added value created by the work of transport is available for immediate consumption, but the whole is exchanged for consumable articles. The process of circulation, by way of exchange or distribution, goes on in either case until so much of the total produce as is required for the support of the community has been consumed, or exchanged for articles which are themselves consumed, in the form of food, clothing, and shelter, and so cease to exist as articles of consumption. Any surplus is available as stock or capital.

It will be seen that the study of the flow of circulation is quite easy near the sources. But afterwards?

Through what channels does the main part of the produce of a pastoral property or a sugar plantation pass, before it, or that which is imported in exchange for it, is consumed within the community? Who are the individuals whom it provides with food, clothing, and shelter? From what sources is the volume of circulation which is found to be existing at any point in the stream derived, and in what proportions? From what sources, and in what proportions, comes that part of the annual income which is applied in the discharge of external obligations, and from what channels, into which it would have flowed if not so applied, has it been diverted?

Again, regarding the phenomena from the other end of the stream, from what sources comes the livelihood of any specific portion of the community, and in what proportions are the contributions from the different sources mixed? What are the ultimate sources of the food, clothing, and shelter of the congested population of great cities? How is it that those necessaries are supplied to them there and not elsewhere?

In order to answer these questions it is necessary, I think, to know the law which regulates circulation in the body politic, and the degree to which the operations of the community conform to that law. If we knew the law, we might foresee and avoid the consequences of its violation.

Let me briefly deal with the subject from another point of view, considering the actual flow or circulation of the money which represents the income of any particular individual. Take the case of a man with a salary of £1,000 a year, and suppose that the income is paid to him in marked coins which can be identified in the hands of the persons to whom they come. This income (except so much of it as he hoards) will all become income of other persons—his landlord or perhaps his mortgagee, his tradesmen, his medical adviser, his servants, and other persons from whom he obtains advantage or amenity. Their incomes will in the same way go to form part of the incomes of others from whom they obtain similar advantages. It would, I believe, be instructive, and I am sure it would be interesting, to trace the course of the flow of the 1,000 sovereigns, and to find the number of persons of whose incomes they form part during a given period—perhaps of the same person more than once—and how much the sum would come to of all the appearances of those same sovereigns. The number would not have been increased, nor the share of the year's produce of the community originally represented by them. But the investigation would show how the £1,000 worth of that produce which had fallen to the control of the individual for the purposes of consumption had been disposed of—how much consumed by himself, and how much distributed, and by what course of circulation, amongst other persons, and consumed by them. The whole £1,000 (except so much as was hoarded) would be found to have been applied in furnishing food, clothing, and shelter to members of the community. It would be interesting also to investigate the stream of circulation of money from the other end, following it up to its sources. We should find, I think, in every case, that the actual consumer, except so far as he himself produces what he consumes, obtains his share of the national income from some person who employs him and who himself procures it from some other person, and so on until we come back to the original producers.

If there is a law regulating the flow of the material life-blood of a community, it is quite certain that any failure to obey that law will result in disturbance of the health of the body politic. When the body is healthy the supply of nutriment to every part of it is adequate. If, then, we find at any time that some members of the community suffer want or privation while others have enough, and perhaps to spare, the natural inference is that some law of health has been violated, and either that the total supply of nutriment is insufficient or that the proper flow of circulation is obstructed. A knowledge of the laws of Nature in other branches of science has only been attained by the patient investigation of phenomena. I think it is not unreasonable to anticipate that a similar investigation of the phenomena attending the operations of the unconscious vital processes of the body politic would be equally fruitful of results. Whether those results would come up to the expectations entertained by Mirabeau as to the effect of the application of Quesnay's *Tableau Economique* I cannot say, but there is at least ground for hoping that they would throw some light upon many social problems urgently demanding solution, and which seem sometimes to be involved in impenetrable darkness.

2.—FACTORY LAWS IN NEW ZEALAND.

By GRACE NEILL, Inspector of Factories, N.Z.

Factory legislation is a necessary outgrowth of the modern industrial system. In the fierce and ever fiercer war of capitalistic competition, the kings and princes of industry have shown a tendency to treat the industrial workers as so much powder and shot—women and children being the cheapest ammunition—to be spent and used up in their service. But times are changing. A glance backward over the social and industrial conditions in England suffices to show how the factory system has proved itself a potent motor-power in directing nineteenth century legislation towards its special characteristic—an equalisation of social rights irrespective of wealth or sex.

It is exactly 100 years ago since early social reformers recognised the growing abuses connected with the establishment of the Lancashire cotton-mills. In 1795 a committee was appointed in Manchester to report upon the matter, and the resolutions then passed form the guiding principle of the earlier Factory Acts. Dr. Percival, a member of this committee, made, in the year 1795, a proposal to apply "for parliamentary aid to establish a general system of laws for the wise, humane, and equal government of all such work"; and now, in 1895, we find factory laws an accepted necessity for the just government of any State. England led the way, America followed; and now New Zealand may claim to be in advance with her comprehensive Factories Act of 1894. England and America had to deal with remedial measures—long hours of labour, overcrowding, slum-sweating having taken root in their populous centres. In New Zealand the industrial centres are comparatively small and easily supervised, whilst successive Governments, of whatever shade in politics, have been keenly alive to the necessity for warding off the evils so difficult of eradication in older countries. Her measures are therefore preventive rather than remedial, and have been steadily progressive in their growth.

The first step in the direction of a Factory Act in New Zealand seems to have been taken more than twenty years ago by the "Employment of Females Act, 1873," introduced by Mr. Bradshaw, a private member during the Vogel Ministry. It is very short, consisting of only five sections. "No person shall employ any female at any time between the hours of six in the afternoon and nine in the morning, or for more than eight hours in any one day." This is indeed a radical reform when one considers that it was introduced twenty years ago, and that few countries have arrived at the point of eight hours for female labour even in 1895. "Every female shall have holiday on every Saturday afternoon from two o'clock, and on Sunday, Christmas Day, New Year's Day, Good Friday, Easter Monday, and any other day set apart as a public holiday, without loss of wages." Here is a second radical reform, inasmuch as it deals with the wage question, and decrees that the always poorly-paid woman worker shall enjoy her legalised holiday on Saturday afternoon and other days without feeling that she will have to pay by a reduced pittance for a rest that is of advantage to her well-being. "Every workroom shall be properly ventilated." A short but weighty section.

For the purposes of carrying out these provisions, "Any person authorised in writing by a resident magistrate may enter and inspect any workroom at any time *during working hours*." There seems to be a weak place here, for, as there is only right of entry during working hours, it would not be easy to check the growth and extension of overtime labour. This brief but important Act is slightly amended in the following year, 1874. First of all, in the interpretation, "employ" in the 1873 Act was to apply to all kinds of manual work and labour—"not being contract or piecework." Evidently the female workers must in some cases have been put on piecework in order to evade the section ordaining Saturday and other holidays, for in the amendment of 1874 "employ" is to apply to any manual labour exercised by way of trade, or for purposes of gain in or incidental to the altering, repairing, ornamenting, finishing, or otherwise adapting by way of trade or for purposes of gain or for sale of any article." The hours of work, although eight a day, were extended from 9 a.m. to 8 a.m., and an important clause added to the effect that upon the employer of female labour should rest the onus of sending in a written statement to the resident magistrate's court detailing the hours of work of females in his employ. The following year we find a further outgrowth in an Amendment Act, 1875. And here for the first time comes in the word "factory"; the interpretation of factory being "any manufactory, workshop, or other establishment or business where any female, child, or young person shall be employed." "Child" shall mean boy or girl between ages of ten and fourteen; "young person," fourteen to eighteen. There is a penalty of £50 attached to the employment of a person under the age of ten years.

The 1875 Amendment Act also regulates that neither children, young persons, nor females shall be employed continuously for more than four hours and a-half without an interval of at least half-an-hour for a meal, and that children—*i.e.*, from ten to fourteen shall only be employed for half-a-day, or on alternate whole days, and that neither children nor females are to be employed during hours set apart for meals. Employers are bound to post up notices specifying hours of employment, and forward copies of same to the resident magistrate's office, and also to the inspector of police for the district. Certain special regulations and exceptions are made for woollen mills, printing offices, &c. Retail saleswomen are exempt from the Act.

By this bird's-eye view one may see that the factory legislation in New Zealand began in a purely tentative manner; each step in advance was but a natural sequence and development. There was no rushing into legislation in obedience to a popular cry; but, on the contrary, the law-makers were practically educating the people. The next we hear of factory legislation is six years later, in 1881, when a Bill was brought in to consolidate the three previous Acts. It passed both Houses with an amendment in committee raising the limit of age of employment from ten to twelve years. "No person shall be employed in any factory under the age of twelve years." Here factory legislation rested for three years, when a flaw in the working of the Act was detected and remedied in 1884 by the omission of the words "during working hours" in the clause dealing with factory inspection, thus giving authorised inspectors the power to enter and inspect factories and workrooms at any time. Of course, unless the inspectors had this power it would be absolutely impossible to check the growth of sweating and overtime work. The following year a further amendment was made, containing special provisions as to fruit-preserving, fish-curing, and printing offices. It provides that all persons working overtime shall receive additional wages for the same, and that no female or young person be employed at overtime for more than four days in any week. This 1885 Act also says that if in any town or district Saturday be not suitable as a half-holiday, another day may be appointed by the local authorities and publicly notified as a day on which women and children shall have holiday from 2 p.m.

In 1890 a royal commission consisting of nine men was appointed "to inquire into the mode and terms in and on which persons are engaged or employed in any manner in supplying or making goods or articles for the owners or occupiers of such shops or wholesale or retail trading or manufacturing places of business or otherwise, and upon the relations generally of employer and employed, and the best machinery for determining matters and questions arising between them and relating to their respective interests." This seems rather a large order for a commission of mortal men; and if these nine gentlemen had succeeded in getting at the roots and remedying the evils of a tithe of the varied social problems thus presented to their notice for inquiry, the world would be very much nearer industrial peace and prosperity than it apparently is in 1895. The commission carried on its investigations in Dunedin, Christchurch, Wellington, and Auckland during February, March, and April, 1890, and presented a report early in May, upon which has been based much of the subsequent factory legislation in New Zealand.

Following upon the report of this commission we find that in the session of 1890 a Factories and Shops Bill was introduced by the Colonial Secretary (Atkinson Government) dealing with factories, workrooms, and shops. This Bill proposed to establish what would be practically a separate department under a Minister. It proposed the division of the colony into factory districts under the supervision of inspectors. In this Bill the precedent of Victoria was followed by the inclusion of shops, and it was provided that shops should be closed each day except Saturday at 6 o'clock, and on every Saturday at 10 p.m., certain businesses being excepted. The working hours for women and young persons (under eighteen) were to be fifty-two a week. However, this Bill lapsed in the House of Representatives after second reading.

The next year, 1891, the Hon. W. P. Reeves, Minister of Education in the Ballance Government, successfully carried through both Houses a Bill to provide for the supervision and regulation of factories and workrooms. This is known as the "Factories Act, 1891," and came into operation on the 1st of January, 1892. An outcome of this was the formation of a distinct Government department under the charge of the Hon. W. P. Reeves, Minister of Education, who now holds the additional portfolio of Minister of Labour. New Zealand is thus the first country to give labour direct representation in its Executive Council. Mr. Edward Tregear, the head of the department, is Secretary for Labour and Chief Inspector of Factories, and has under him a total of 163 local inspectors, each with an allotted district. Of these inspectors, five are attached to the Department of Labour, and are stationed at Dunedin, Christchurch, Wellington (2), and Auckland respectively. There is one woman inspector appointed for the North Island, and the remainder are police officers, gazetted as local inspectors of factories in their own districts.

This Act of 1891 is the basis of our present legislation in regard to factories and workrooms. In it "factory or workroom" is defined as a place where *three* or more persons are at work. "Child" is a *boy* under *thirteen* and a *girl* under *fourteen*. Cases are to be tried before a resident magistrate *or* two or more justices of the peace. This Act was slightly amended in 1892, chiefly in respect to sanitary regulations. In that session also the Minister of Labour carried through a Shops and Shop Assistants Act, to be worked in conjunction with the Factories Act, limiting the hours of business in shops.

During the session of 1894, Mr. Reeves introduced Bills to consolidate and amend the Factories Act, 1891, and the Shops Act, 1892. Both were passed; the former came into operation at once, the latter upon the 1st of January, 1895.

The Factories Act, 1894, under which we are working at present, is built on previous Acts, modified and extended in the directions found advisable after two years' practical experience of departmental working. In it a factory or workroom is defined as any office, building, or place in which *two* or more persons are engaged working for hire or reward in any handicraft, or in preparing or manufacturing articles for trade or sale; and the occupier of a factory or workroom has to register annually before the 21st January, paying a fee according to schedule. The fee is 5s. per annum if not more than eight persons are employed, and goes up to two guineas in cases where there are more than thirty employees. Records of names of persons employed, the ages of those under twenty, the description of their work, their weekly earnings have to be kept and produced for the inspector when demanded. Notices are posted up in each workroom with the name and address of the inspector and the working hours and holidays of the factory. The occupier has also to keep a record of work done for him elsewhere than in his factory; and if it is done in a place not registered as a workroom, or in a private dwelling, must affix a label (according to schedule) to the articles thus made for sale, stating that they have been made up in a private dwelling, and giving the name and residence of the worker. The importance of this clause in checking sweating is self-evident. Take the lowest-paid work as an example —shirt and bag making. (One must remember here that in New Zealand there is a duty of 25 per cent. on imported made-up garments; consequently large local factories have been established for this description of work.)

The registered shirt and slop factories are arranged in conformity with the factory laws — well-lighted, well-ventilated, with every sanitary convenience, with fixed working hours and holidays, and open to inspection at any time. But a woman goes to a retail trader and offers to machine shirts for him at perhaps 6d. or 1s. a dozen less than the wholesale factory price. She may do this by employing one or two young girls, and probably working long hours under insanitary conditions—in fact, here we have the beginning of the sweating system. Under this new clause of the present Act she finds that, if she employs even one girl, she must register as a factory and keep within the law, or, if she takes work home from a shop, her employer must label the goods as coming from a private dwelling. In the working of this section we find that the wholesale and retail firms dislike the idea of affixing the label, and that this will act as a check to the giving-out system and consequent under-cutting of prices. I should add that in cases where hardship is likely to arise—say in the case of a widow with a young family—special written exemption may be given by the inspector.

The Act provides with detailed care for the safeguarding of machinery, for cleanliness, ventilation, space, and other sanitary matters. Fire-escapes have to be provided, and all doors of a factory or workroom must be hung so as to open outwards, and neither locked nor fastened in any way during working hours. If more than six women or persons under sixteen are employed, a room must be provided for them (with seats and tables) in which to take their meals. Shearing-sheds, where more than four are employed, are also included in the Act. The inspector is bound to ascertain at least once a year that the dwelling-places and working-places of the shearers are cleanly and in a fit and proper state for the reception of workmen, and that necessary accommodation is provided.

Now let us turn to those parts of the Act dealing with the age of the employees and their hours of work. No child—*i.e.*, boy or girl under fourteen—may be employed except in small factories where not more than three persons are employed, and that only in special cases with the sanction of the inspector. No person under sixteen is to be employed without a certificate of fitness for the work, nor unless the inspector is satisfied that he or she has passed the fourth standard or an equivalent educational test. No person is allowed to employ a boy or girl under sixteen, nor any woman for more than forty-eight hours in one week, nor after 6 p.m., except that with a written permit from the inspector such persons may work for not more than three hours beyond the usual working hours on twenty-eight days in the year. The pay for overtime must in no case be less than 6d. per hour. The written permit to work overtime has to be posted up in the workroom, and a register is kept in the office of the department of the names of those working overtime and the dates of their doing so. No woman may be employed in a factory during the four weeks immediately after her confinement. With respect to legalised holidays, the occupier of a factory (a few businesses are exempted from this) must allow to every woman and to every person under eighteen in his employment the following holidays:—Christmas Day, New Year's Day, Good Friday, Easter Monday, the sovereign's birthday, and every Saturday afternoon from 1 o'clock, without any deduction of wages. There is one more section amended in this Act that I must not omit to mention, and that is the provision that all proceedings under the Act must be heard and determined before a stipendiary magistrate alone. The justice or "two or more justices of the peace" may not always be impartial in these cases. Such a comprehensive Act, and one so full of detail, would probably have been found difficult to work with new and untried machinery. But, as I said before, it is the outgrowth of twenty years' tentative effort on the part of successive Governments of various political shades to improve the condition of the women and the young workers, and to prevent the seeds of the sweating evil from taking root in New Zealand.

The Shop and Shop Assistants Act, 1894, should be noticed as it is worked in conjunction with the Factories Act. It provides that "all shops in a city, borough, or town district, except those wherein is carried on exclusively one or more of the businesses of a fishmonger, a fruiterer, a confectioner, a coffee-house, or eating-house, or railway bookstall-keeper, shall be closed in each week on the afternoon of one working day at 1 o'clock. But still those excepted are compelled to give every assistant one half-day in each week. The word "shop" does not include any small business carried on by Europeans with the assistance of members of their own family under eighteen years of age. Goods may also be supplied to vessels arriving in port after proscribed hours. With the local authorities in each district rests the decision upon which day of the week the general half-holiday is to be held, and if they cannot agree then the Governor in Council must decide it. As I write, this week before Christmas, the rival merits of Wednesday and Saturday as the general half-holiday for Wellington is a theme for vigorous discussion in the correspondence columns of the local papers. Those who make a practice of closing on Saturday may continue to do so, whatever be the day fixed. In Wellington hitherto all drapers and a good many grocers have closed on Wednesdays; some other shops have closed on Saturday, and some have kept open every day, giving their assistants the legally prescribed half-holiday in turn without closing. It has been a difficult matter for the inspector to assure himself that some of these assistants got their half-day with any regularity. By this amendment in the Act there will be uniformity of practice.

Shop assistants are entitled to one hour for dinner, and no woman or person under eighteen years of age can work for a longer period than fifty-two hours in any one week or nine and a-half daily, except one day in the week, when eleven and a-half may be done. But no one must be employed for more than five consecutive hours without having at least half-an-hour for refreshments. Every shopkeeper is required to provide proper sitting accommodation for females employed in his shop, and not directly or indirectly prohibit or prevent an assistant from using a seat when not immediately engaged in her employment. All offices and banks are included in this Act, and their closing hour must not be later than 5 daily and 1 on Saturday, but cashiers and bookkeepers may balance their books before leaving. For six days in the month employees may continue at work, or return to work, for not more than three hours. Shipping, tramway, and newspaper offices are excepted. Offices are exempt from these regulations during two months in each year for the purposes of their half-yearly balances. As this Act does not come into operation until 1st January, 1895, I can give no information as to the carrying out of its provisions.

People often say to me, "Are not your duties as inspector of factories very unpleasant? Surely the employers resent your visits?" To such queries I can only answer that, after visiting towns and country districts throughout the North Island, I have found employers not only courteous in their personal treatment, but also most willing to adopt any suggestion that could add to the well-being and comfort of the women and girls employed. Of the working girls of New Zealand I would say that it is a pleasure to look round the larger factories and see such well-clad, well-nourished, bright, and happy-looking young women. Factory legislation is but the elder sister of free and compulsory education; they must work hand in hand, and their co-operative success in New Zealand augurs well for racial development in the future. States do not grow healthily from the top downwards, and undoubtedly the country that secures wholesome conditions of life and freedom to its weakest members, that keeps a standard of good citizenship before its young workers and its women, lays a foundation of social strength and peace not easy of assault.

3.—THE TORRENS SYSTEM OF REAL PROPERTY LAW.

By J. B. GREGORY, B.A., LL.M., Barrister-at-Law, Lecturer on the Law of Property in the University of Melbourne.

I propose to offer a few remarks upon the system of real property law which, originally introduced into South Australia by Sir R. R. Torrens, has since been adopted, with modifications in point of detail, throughout Australia. I shall take as my type the law in force in Victoria, which is the only form of the system with which I can claim more than a cursory acquaintance, but I believe most of what I have to say will apply to the forms of the system in force in the other colonies.

The principal object of this system was to remove or lessen the difficulty and expense of proving title, either as between vendor and purchaser, or mortgagor and mortgagee, or in a court of law; and the general method of the framers of the system was to apply to land the principles of the law of merchant shipping. This law was framed to carry out the policy of the Navigation Acts, which conferred great, and in many cases exclusive, privileges of trade upon ships owned and built in the dominions of the British Crown. In order to carry out the provisions of these Acts it was necessary to provide a means of readily determining the owner or owners of a British ship, and for this purpose the system of registration was devised. In this way the law relating to ships came to differ from the law relating to other chattels to which no evidence of title beyond possession is ordinarily required.

The general principles of the system were these: Every British ship had to be registered with a public officer who issued to the owner a certificate of registry. All dealings with the ship had to be by instruments of a stated form, and took no effect until they were registered by the same officer. The result was that it was always easy, by inspecting the registry, to ascertain that some definite person or persons were the owner or owners of the ship either absolutely or subject to charges of an easily ascertainable character.

It must be noticed that this effect was obtained by admitting to registry instruments of a stated description and form only. And among the instruments excluded from registry were all instruments creating trusts and other equities. Under the older Merchant Shipping Acts equities affecting ships were not recognisable in any way at law or in equity, but under the more modern Acts such interests have been made binding personally upon the persons who have subjected themselves to them, though not upon purchasers even with notice.

The object of Mr. (afterwards Sir) R. R. Torrens was to apply the principle of these Acts to land. They obviously afforded a system of ready proof of title. Complications were obviated by the provisions that equities should not have the protection of registration. They were still further avoided by the requirement that instruments should be in a prescribed form, thus preventing uncertainties arising from the vagaries of particular individuals. The ascertainment of the title was rendered easy by the requirement that no instrument should take effect until it was registered at the port of registry as affecting the particular ship.

The application of these principles to land does not give quite the same simplicity of title as prevails in the case of ships. A ship is a natural unit; there is no fear that anyone who is entitled to the barque "Mary" will instead get possession of the forecastle only of that ship, together with the stern of the brig "Jane"; but if anyone is entitled to allotment A he is very likely indeed to find himself in possession of part only of that allotment, together with a part of the adjoining allotment B.

It will be noticed that difficulties of this sort are not at all alleviated by the Torrens system. In fact, they are rather aggravated. The names of the successive owners and other particulars as to the property appearing upon a chain of title deeds lends an aid to the identification of the parcels, which is lost when the sole document to rely on is a certificate of title which does not contain any reference to the past history of the land in question.

Again, such rights as easements and profits *a prendre* are unknown in the case of ships. Ships are not the subject of family settlements unless carried out by way of trust; and though the chartering of a ship has a close analogy to the leasing of land, the duration of charter parties is short compared with that of leases. Finally, a ship steadily deteriorates in value from year to year, so that all questions concerning her become of less and less importance until they are put an end to by her being broken up or lost. It is far otherwise with land, which often increases in value so that questions at one time hardly worth consideration become in time of great pecuniary importance. Not merely does land increase in value, but it often changes its character. The application of easements acquired in a rural neighbourhood for the convenience of the owner of an adjoining farm may have to be determined when both tenements are covered with houses. No question of this sort arises in the case of ships.

Of these difficulties, that concerning parcels has been found of practical importance, and Act after Act has been passed in Victoria to remedy it.

The inapplicability of the merchant shipping law to family settlements of legal estates has not given rise to the friction which might have been expected, not from any ingenuity on the part of the framers of the law—which on this point appears not a little obscure—but because it is not a common practice in Victoria to make settlements of legal estates, even in the case of land. When it is desired to settle land upon the different members of a family, the course is nearly always followed (at all events in Victoria) of vesting the legal estate in trustees and giving equitable interests merely to the persons beneficially entitled.

Again, such rights as profits *a prendre*, which make such a large figure in English law, mostly arise out of the manor system, and accordingly are almost unknown in a country where that system has never existed. Little practical inconvenience has arisen from the obscurity of the law under the Torrens system concerning them.

Easements are much more common, but still the way in which land has been cut up for sale in blocks, with wide roads running through it which are dedicated to the public, renders them of much less frequent occurrence than they would be in a neighbourhood which has had more regular and continuous growth. But, notwithstanding this, there has been a good deal of amending legislation on the subject of easements, and the law cannot now be said to be in a clear or satisfactory state concerning them.

As regards covenants running with or binding on the land, the law under the Torrens system is perhaps still more perplexed. At common law the burden of a covenant, unless perhaps it be a covenant to produce title deeds, never runs with the land except between landlord and tenant, but a purchaser with notice of a restrictive covenant or a volunteer is bound by such covenant in equity. Now the Transfer of Land Act, 1890, and the Acts from which it is copied, if their words are taken in their natural import, would make all covenants entered into by the transferror binding upon the land and the transferree. In the one case in which this language has come under the consideration of the Supreme Court of Victoria—that is, the case of a mortgagee who claimed to recover his mortgage money personally from a transferree of the land subject to the mortgage—the court held that this language was not to be construed in its natural sense, but merely gave the mortgagee rights similar to those he would have had in an analogous transaction under the old system.* Supposing this case to have been well decided, one may suppose that a similar principle will be applied to the construction of similar language in analogous cases throughout the Act. This application, however, is not free from difficulty. Take the case of an absolute transfer subject to a restrictive covenant not to use, or permit to be used, any building erected on the land as a public-house. The burden of such a covenant would not run with the land upon a conveyance in fee-simple at common law, but it would be binding in equity on a purchaser with notice. Now, if the words of the Transfer of Land Act were taken in their natural import, land would become subject to the covenant at law as soon as a transfer was registered. If, however, these words are cut down so as to apply only to covenants that would run with the land at common law, the question would then arise whether it was consistent with other parts of the Act to apply the equitable doctrine by which a purchaser with notice is bound by a restrictive covenant. It would not seem that he could be bound by reason of notice unless the covenant were entered as an encumbrance on his certificate of title, but that might be done. It would seem probable, therefore, that land under the Act may be made subject to restrictive covenants at least as extensively as land under the old system, but the fact that these questions have remained undecided for so many years shows that it is not the habit of persons in Victoria to seek to bind land with such covenants.

* Australian Deposit and Mortgage Bank *v.* Lord, 2 V.L.R., L. 31.

As part of the law of merchant shipping, the provision that trusts should not be entered on the register rather preserved the substance of the law, as it existed with relation to other chattels, than made any departure from it. For though when chattels are held upon trust a purchaser with notice is bound by the trust, a purchaser of chattels, not being under any obligation to inquire into the title to the chattels he buys, would not usually acquire notice of any trusts affecting them. It is otherwise with the case of land not under the Torrens system. A purchaser is there under the obligation to investigate the title, and whether he does so or not would accordingly be for the most part affected with notice of any trusts which appeared on the deeds which were necessary to manifest it. A great change, therefore, was made in the law relating to land when it was enacted that no trust should be entered on the register, and no person dealing with a registered proprietor should be affected with notice of any unregistered interest.

Whether this change would have been considered satisfactory if the law had been carried out as apparently enacted it is difficult to say; but the Titles Office in Victoria has adopted a practice of entering a notice upon every certificate of title which is known in the office to be subject to a trust, and of then, when a dealing is submitted for registration, making inquiries to ascertain that it is not a breach of trust. This practice must afford a very considerable protection against breaches of trust, though, on the other hand, it must throw obstacles in the way of the registration of *bonâ fide* dealings by trustees. Though established many years, it has never been questioned. Apparently in a *bonâ fide* transaction it is easier to satisfy the office than to dispute the legality of its procedure, and of course, if the transaction is not *bonâ fide*, to dispute the question would be useless. The entry upon the certificate is simply the letters S.O., which stand for special owner; but to any practitioner they must be a notice of a trust. This S.O. practice, as it is called, brings it about that the change made in the law by reason of the not entering of trusts upon the register is not in practice by any means as great as would appear from the words of the statute.

We see, therefore, that except upon the question of parcels the differences between land and ships have not, under the existing circumstances of Victoria, produced the degree of practical inconvenience in the application of the law of merchant shipping to land which might have been anticipated, and, notwithstanding the differences between land and ships and the differences which must be made in the law relating to them, the system of conveyancing contained in the Transfer of Land Act has in the circumstances of Victoria given to dealings with land to which it is applicable a great deal of the simplicity which prevails with regard to ships.

There is one point in which it appears that the Torrens system is fairly the subject of adverse criticism. Instead of modifying the existing system of law, it introduced a different system which should apply to some land only, thus very greatly complicating the law. It was no doubt expected by the framers of the Act that all the land in the country would be brought under its provisions, and this will probably be eventually the case, but not till after the lapse of many years. At the end of 1892, about four-fifths of the land alienated from the Crown in Victoria was under the provisions of the Act, and the remaining fifth would probably bear a higher proportion to the whole in value than in area. In thus introducing an immense exception to the general law, instead of amending that law as a whole, I venture to think a great error was made. That the course adopted was not at all necessary it will not be difficult to show, but to do so it will be necessary to consider in detail the leading principles of the Torrens system. The first may be stated thus: That interests in land are not affected except by registered instruments. There seems no possible reason why this principle should not have been applied to all land. It might have been enacted quite generally that no instrument affecting land, except a lease for a term not exceeding three years from the making of it, or the surrender or assignment of a term not exceeding three years' duration from the date of the assignment or surrender, should take effect except from its registration.

Again, under the Torrens system, the duties of the registrar are not merely ministerial. He has to exercise a discretion as to whether an instrument lodged with him is a proper instrument to be registered. In this way it is rendered impossible, or, at all events, very difficult, to put on the register any documents which would cloud the title. There is no reason why this provision should not be made perfectly general.

Again, under the Torrens system, an instrument can only be registered as affecting particular land. If the registrar is made an officer empowered to exercise a discretion, this principle might be applied to all instruments affecting land whatever.

So, again, a person dealing with a registered proprietor is not affected by notice or knowledge of any unregistered interest. Why should not this principle be made quite general?

Again, under the Torrens system, trusts cannot be registered. This principle, either in the form in which it appears to be enacted or in the form in which it is carried out, might be made a general proposition applicable to all land without exception—that is, in the latter case, if the registrar is made an officer empowered to exercise a discretion as to whether the instruments he registers can be properly registered in accordance with law.

Again, under the Torrens system, a purchaser is entitled to assume the validity of any registered dealing with an actually existing person, and a person deprived of land by a mistake in the office, or otherwise by the operation of the Act, is commonly entitled to recover compensation out of a fund made up of fees levied upon registration and their accumulation. This principle might be extended generally.

Another change introduced by the Torrens system was in the simplification of the language of instruments.

It may be interesting to notice the causes, mainly historical, which made a conveyance of land so lengthy and cumbrous.

1. Our ancestors appear to have thought that when a man was given an estate in land for his life, he had been given all that was possible to give him, and all that could be done further was to give the land to his heirs after him. In process of time, the ancestor acquired as against his heirs the power of alienation, first *inter vivos* and afterwards by will, so that an estate limited to a man and his heirs became what is now known as an estate in fee-simple. Still, the

only way to confer it was as of old, by giving it to the man and his heirs, and out of this doctrine arose the rule in Shelley's case with all its complications. The necessity of using the word heirs to convey a fee-simple has been done away with in England, and it ought to be done away with in Victoria irrespective of any process of bringing land under the operation of the Transfer of Land Act, 1890.

2. Another cause of complexity of language in conveyances arises from the Statute of Uses. This, as is well known, was an attempt made in the reign of King Henry VIII. to abolish trusts by turning them into legal estates. This object, as is equally well known, failed; but the Act has had the permanent effect that language which, taken in its ordinary sense, would confer a legal estate on one man and a beneficient interest on another, often gives the legal estate to the man who appears to have only the beneficial interest. We have here another case in which an elaborate and awkward system has grown up of interpreting language in a non-natural sense. I can see no reason why this venerable statute should not be repealed, taking care by so doing not to lose the extended power which is conferred of creating legal estates and effecting dealings with land which could not be created or effected by the common law. The Transfer of Land Act, 1890, or any of the Acts it supplants, has not repealed the Statute of Uses as to land under it, but has enabled the dealings which required the operation of the statute of uses to be effected without relying on that statute. Notwithstanding the Statute of Uses not having been repealed as to land under the operation of the Torrens system, so far as I know no question has ever arisen as to its operation with regard to such land. I presume this arises from the joint operation of two provisions—one that which prohibits the registration of any instrument which creates trusts, the other that which requires registration in order to pass a legal estate; the results of which would be that either an instrument would not declare uses or trusts, and would accordingly not give rise to any question under the Statute of Uses, or it would not be registered, and so would not confer a legal estate.

3. Another ground of complexity in conveyances of lands arises from the practice of drawing them so as apparently to make the conveyance twice over—first in the premises and then again in the habendum. This practice probably arose from copying charters of feoffment where the statement in the premises, properly in the past tense, was intended for a record of the livery of seisin which had already taken place, and the habendum was intended to state with particularity the estates intended to be conferred by that livery. The forms prescribed under the Torrens system lay aside this practice, and there seems no reason why it should not be laid aside universally.

4. Another ground of complexity arises from the covenants for title. The object of these covenants is to give the purchaser a personal remedy against the vendor in the case of concealed conveyances by the vendor, his ancestors, or testators. They appear of little use in a country where a general registry Act is in force, and it would seem therefore the legislature of New South Wales might have provided for their discontinuance when it passed the Act 6 Geo. IV., No. 22, and it would seem that no considerable inconvenience would be occasioned by providing for their discontinuance. Another available

course would be to provide that every conveyance should imply the covenants for title which might now be insisted on, having regard to the interests of the conveying parties, and that no one should be entitled to express covenants without stipulating for them.

In England the Conveyancing and Law of Property Act, 1881, contains express provisions for implying covenants for title in conveyances, and the covenants to be implied vary according as the conveying party is expressed to convey as beneficial owner, trustee, mortgagee, husband of a married woman, settlor, &c. This system requires that the character in which the conveying party conveys should be expressed in order to subject him to covenants. If it is desired to abolish express covenants for title in Victoria, I doubt whether it will be expedient to adopt it. The risk involved in a covenant for title is usually small, and ought to be nothing. It is little advantage to a purchaser to know whether he has the covenants of a trustee or of a beneficial owner, for he is bound to accept covenants suited to the situation of the vendor, whatever that may be, and it must be very rarely that there is any difficulty in ascertaining what that situation is. It would seem, therefore, quite sufficient to enact that a conveyance should imply the description of covenants which could now be insisted on, and leave that matter to be determined in the rare cases in which it arose. Under the Torrens system covenants for title drop out as of course, the purchaser, being absolutely protected from unregistered interests, has no need for any further protection by way of personal covenant. In case of a general extension of the Torrens system to all land, covenants for title would cease to be of any use, and might be safely abolished.

The general words and the estate clause have been abolished in England and might be abolished here.

Covenants for the production of title deeds have disappeared under the Torrens system. The issue of the certificate of title renders them no longer necessary. By providing for a system of registration in duplicate, one part being left with the registrar, the necessity of the production of future deeds might be avoided in all cases without the necessity for any certificate of title, and if the language of the deeds was simplified as above suggested the expense would not be greater than is occasioned by certificates in duplicate under the Torrens system, but as regards existing deeds some provision for giving the purchaser a right to their production is necessary. Probably the English system contained in the Conveyancing and Law of Property Act, 1881, by which an acknowledgment of the right to production may be substituted for a covenant to produce, would be the best course to adopt.

We see, therefore, that the simplification of the language of conveyances which has been carried out under the Torrens system might, with the exception of the absence of covenants for the production of existing title deeds, or some substitute for such covenants such as the English acknowledgment of the right to their production, be carried out with respect to all land whatever; and, in fact, it might and should be carried out irrespective of applying the other provisions of the Torrens system. I do not think I need notice the provisions of the Torrens system as to leases (they differ so little in practical effect from the old law), nor as to annuities, the subject being of too little practical importance. As regards mortgages there are two systems: where the mortgagee takes his security by absolute transfer, in which case his rights, except that he has a more ample power of sale, are much the same as under the old law; and where the mortgagee takes a mortgage under the Torrens system. In this latter case there are a number of differences from the old law which are but to a small extent derived from the Merchant Shipping Acts. Under those Acts, indeed, the mortgagor remained (subject, of course, to the charge) the legal owner of the ship. This was to avoid trenching on the principle that an alien could not be the owner of a British ship without taking away a power of borrowing money from aliens from the British shipowner. The reason which led to the adoption of this peculiarity is not applicable to land, but it has an operation of another sort which may be advantageous. It makes the interest of the mortgagor which, under the old system, is a mere equity of redemption, a legal estate, and enables him to deal with it by assurances which operate at law and not merely in equity, and which are capable of registration and, subject to registered incumbrances, confer an indefeasible title on the purchaser. The other peculiar provisions relating to mortgages cannot be said to be derived from the merchant shipping law. The most noticeable of them is the provision for foreclosing a mortgage by order of the commissioner of titles without action or suit in court. Probably this procedure is cheaper than a foreclosure action, but it would appear in many cases to be defective. For instance, mortgages are often given over different properties to secure one debt. Thus there might be land under the old system, or chattels, as well as land under the Torrens system, included in the same security. It would not appear at all convenient that there should be separate proceedings to foreclose the different parts of such a security—a proceeding before the commissioner of titles as to the land under the Torrens system, and an action as to the rest. Even if there is nothing included in the security except land under the Torrens system, disputes might arise as to the amount due, and there is no machinery provided for settling them, and this leads up to another remark as to the provisions as to mortgages now contained in the Transfer of Land Act, 1890. It appears to be assumed throughout the Act that the amount due on a mortgage can be ascertained by looking at it, that anyone by inspecting the register can find out not merely that the land is subject to a mortgage, but what is the exact amount of the charge. Now, this is not ordinarily possible. If the purchaser of land subject to a mortgage wishes to ascertain the amount due, he can only do so by getting the mortgagee to admit it; and if the transferee of a mortgage wishes to ascertain the amount due, he can only do so by getting the mortgagor to admit it. If mortgagee and mortgagor do not agree, the matter can only be settled by taking an account in an action. There are several provisions in the Transfer of Land Act, 1890, which illustrate this point of view; thus there is a provision enabling a mortgagor, when the mortgagee is out of the country, to pay the amount due to the Treasurer of Victoria, and the registrar of titles is empowered on the production of the Treasurer's receipt to discharge the land from the mortgage. It seems to be assumed that the Treasurer will be able in the absence of the mortgagee to ascertain what is due, so as to afford him a sufficient protection. I am not aware that any case has arisen where a mortgagee has been defrauded by reason of this provision, but the danger would seem to be obvious.

I do not propose to go into the details of the law as to mortgages under the Transfer of Land Act. I will only remark that, with the probable exception of the provision borrowed from the Merchant Shipping Act, which retains for the mortgagor a legal estate in the land, there does not appear to be any advantage in them sufficient to counterbalance the disadvantage of having two systems of law in force as to mortgages, but if such changes are considered desirable there does not appear any reason why they should not be made perfectly general so as to apply to all mortgages. The Transfer of Land Act, 1890, contains a peculiar set of provisions as to executions. In order to bind land the writ has to be registered against the particular land, and will only bind it for three months. There is no doubt that under this system the purchaser of land at a sheriff's sale is in a much better position than he is in under the Act 54 Geo. III., cap 15, or the various re-enactments of it. He is enabled to make an investigation into the title to land he is buying, which, though not sufficient to exclude the possibility of his being defeated by the holder of an unregistered interest, will enable him to form some probable estimate of what he is buying.

The procedure under 54 Geo. III., cap. 15, appears highly unsatisfactory. No one is accustomed to buy land without a title, and consequently land so sold sells for little or nothing. Perhaps the judgment creditor may himself buy at the sheriff's sale, and so obtain payment of his debt or some part of it, or perchance may obtain a great deal more than payment; but, in any event, the interest of the debtor and his other creditors are sacrificed, the latter more certainly than the former. For if the debtor is not insolvent he will probably raise money and pay out the execution. The procedure under the Transfer of Land Act is only better than that under 54 Geo. III., cap. 15., as a matter of degree. The land is still sold without a title, though an intending purchaser, if he care to take the trouble to make inquiries, has some means of finding out what the title probably is. It would seem better to fall back on the English practice, under which a creditor has first to obtain possession of the lands of the debtor under a writ of elegit, and can then apply to the court for an order for sale, which is made after proper inquiries into the title, and so the land may be expected to fetch a reasonable price as in other sales under the order of the court.

In case of insolvency under the old law the vesting of the land in an assignee or trustee takes place upon the granting of the rule *nisi*. That is a complete bar to any disposition by the insolvent. Land under the Transfer of Land Act, 1890, does not vest in an assignee or trustee in insolvency until he gets himself registered as proprietor, but until the passing of the Act No. 872 the assignee or trustee of an insolvent was entitled to notice from the Titles Office before any dealing by the insolvent was registered. This threw on the Titles Office the onus of inquiry whether any proprietor desiring to register a dealing had become insolvent, and proprietors were consequently often put to much trouble to show that they were not identical with insolvents of the same name. Accordingly under pressure of the demand for rapid conveyancing which prevailed about the time of the land boom, the Legislature of Victoria altered the law abolishing the necessity for any notice by the Titles Office to assignees or trustees in insolvency. The consequence is, that as the law now stands an insolvent is quite free to deal with land under the Transfer of Land Act, 1890, until the assignee or trustee intervenes. Solvent persons are thus saved the trouble and expense of proving that they are not identical with insolvents of the same name, but there would seem to be considerable risk that an insolvent might defraud his creditors by selling land immediately after the sequestration and absconding with the price before the assignee or trustee had time to make the necessary inquiries to enable him to get registered and lodge a caveat. It would seem that the change went too far, and that the order of sequestration ought to bind the land for a certain time without being registered say, for three months. This would cast upon a proprietor applying to register a dealing the onus of showing that his estate had not been sequestrated within the last three months, which it would not usually be difficult to discharge. If the system were made general of only binding land by instruments registered against it under the supervision of an officer whose duty it was to exercise judicial discretion, there would be no difficulty in putting orders of sequestration in the same position as other instruments.

The certificate of title stands in a different position from the other parts of the Torrens system we have been considering. They might be extended to all land by the mere fiat of an Act of Parliament; but it is impossible to entitle anyone to a certificate of title which will confer on him an indefeasible title against all the world without instituting a rigorous investigation into his title; but that does not seem to be any reason why the rest of the law should not be made generally applicable—that is, quite apart from the granting the certificates of title. There is no reason why the simpler form of conveyances which prevails under the Transfer of Land Act, or any simpler or better form that can be devised, should not be made of universal application; why instruments should not be registered against the land to which they relate, and take effect so as to bind the land only from registration; why this registration should not be made subject to the direction of a responsible officer; why a purchaser of one piece of land rather than another should be bound to concern himself with the trusts affecting it, or be affected by notice of an unregistered interest; why a system of mortgaging should not be created which, while giving the mortgagee legal as distinguished from equitable rights for the enforcement of his security, would leave a legal interest in the mortgagor. The remaining provisions as to mortgages, and also as to executions and insolvencies, I think would be better amended than generalised; but if the generalisation of them was desirable it might be effected.

I may say that the obscurity of the law arising from the complexity produced by two different systems is by no means merely theoretical. I notice in particular that students often fall into error in consequence, and the student is the father of the practitioner as the boy is the father of the man.

4.—A LIVING WAGE.

By Rev. REGINALD STEPHEN, M.A.

The term "a living wage" is an unfortunate one, for it suggests a wage which just enables the worker to live—a bare subsistence wage. The real meaning of the expression is rather a wage which will enable the ordinary working man to live in decency and comfort, according to the standard of life for his class, or as one writer puts it—"the ordinary rate of wage which the ordinary workman has earned in ordinary times."

It is now proposed that for each trade this shall be, for a certain period, the fixed minimum rate of wage; the rate to be reconsidered at the end of the period. The proposal has been rapturously received by the working classes; it has been formally accepted as a desirable step by certain philanthropic bodies; and it has been advocated by some of the leading economists in England. We may then try to trace its probable economic effects at the present day.

Two cases must be distinguished. Upon the ordinary worker in ordinary times the guarantee of the ordinary rates would have little effect. It would simply mean telling him that so long as he had employment he would be sure of receiving the same rate as he received at present. So long as he had employment, he need not fear sudden variations, except at the end of the fixed period. His only gain would be a slightly increased sense of security.

But in the case of inferior workmen, or in bad times, the proposed scheme would have a very different effect. To give the average rate of wages to a man whose powers were below the average, would generally mean to give more than has been earned. So to give in bad times, when prices are low, the same rate as in good times, would generally mean to give more than has been earned. The living wage, as defined above, has not in such cases been produced by the worker's labour, and yet it is paid to him. There must be an economic loss. The loss will not be quite so great as might at first sight appear, for the payment of liberal wages will stimulate and increase production, even by the inferior workers. But some loss there must be. And this loss falls upon the employer of labour. His profits are correspondingly diminished.

A most desirable result may be the verdict of the worker who compares his living wage with the supposed income of the employer. But other and less desirable consequences follow. Even in good times some employers cannot bear any decrease of profits, and in bad times nearly all are dangerously near the margin of non-profitable enterprise, certainly in no condition to bear an extra loss from the payment of too high wages. And if these wages must be paid, the only resource is to stop the business and discharge the men. It is impossible to force employers to pay a higher rate of wages than their business will bear. Any attempt to do so must lead to a contraction of industry, and consequent decrease of employment.

The effect, then, of guaranteeing "a living wage" to inferior men, or in bad times, will be to increase the number of the unemployed. But this effect is in many cases not only foreseen but desired, on the ground that it will make the social problem easier to deal with. The number of the unemployed will increase, but the sweated classes will disappear; and it is held that it is easier to provide for the unemployed than to give adequate and effective relief to the sweated.

Possibly; but it is well to see the principle at the root of this plea. It is assumed that Society is bound to provide for the unemployed. Those who can get work are to be paid fair wages. But those who are excluded from the artificially restricted circle of employment are to be maintained at the expense of their more fortunate neighbours. Of the reasonableness of this plea I have nothing to say at present. But it must be taken for granted if a living wage is to be given. There must be a guarantee from the State that the unemployed will be supported at public expense.

A familiar fact will show the truth of this statement. The rates fixed by trades unions are practically an attempt at a living wage. Now, in good times they are maintained without difficulty; but in bad times they are not adhered to. They may be nominally maintained; but the exceptions and evasions are so numerous that, for all practical purposes, the union rates are discarded. And this of necessity. There is no State provision for the unemployed; and so the workers prefer to work at a lower rate of wage rather than run the risk of having no wages, and there is not even a promise of support from a benevolent Government. So it would be on a larger scale. For the guarantee of a living wage to be effective, there must be a second guarantee that those thrown out of employment will be granted a satisfactory maintenance.

The economic effect of this proposal is clear enough. The sweated class will disappear, or, to speak more accurately, will be reduced in numbers. But at all seasons, and especially at bad seasons, the field of employment will be restricted, and the numbers of the unemployed largely increased.

But, as the State must undertake to provide a satisfactory maintenance for all those who cannot get work at a liberal rate of wages, the social effect is not so clear, and certainly the prospect is not inviting.

5.—A PROBLEM OF FEDERATION UNDER THE CROWN.—THE REPRESENTATION OF THE CROWN IN COMMONWEALTH AND STATES.

By R. R. GARRAN, B.A.

Canadian federation raised, and Australian federation raises, a problem with which the constitutionalists of America and Switzerland had nothing to do. They had to parcel out the sum total of political sovereignty among the States and the Nation. In our case, as in the case of Canada, the real "sovereignty" is outside the federation altogether; what we have to parcel out is only a permissive quasi-sovereignty of indefinite extent. The difficulty lies not merely in there being three grades of political entities instead of two—the Empire, the Commonwealth, and the States; that would be quite simple in theory, if the federal relation were recognised throughout—the Empire being a federation of Commonwealths just as the Commonwealth would be a federation of States. That would be merely a case of federation within federation, which presents no special theoretical difficulty. The difficulty of what is known as Federation under the Crown arises from the conflict of two principles: the British-colonial dependency principle, which centralises all sovereignty in the Imperial Parliament, and the federal principle, which divides it between central and local governments. In order to determine how the two principles can best be reconciled in practice, it is necessary first to look at the exact nature of their conflict.

Federalism, then, introduces a new conception of political sovereignty—one which it is hard to square with the classical definitions. Its essence is the distribution of limited sovereign powers among central and local governments, and the clear delimitation of those powers in a Federal Constitution. In a supreme Federal Government, such as the United States, the powers and the limitations of the States and of the Union are to be gathered from the Federal Constitution alone—are matters of legal interpretation from the terms of the Constitution itself.

The British-colonial system has points of likeness and points of difference. Colonial legislatures are also subordinate, but in a very different sense. Their limitations are indeterminate, and cannot be defined by any amount of legal interpretation. It is true that the Constitution Act of a British colony does define the outside limits of its legislative power—limits which the colonial legislature is powerless to exceed; but this is without prejudice to the rights of the sovereign British Parliament, which can override colonial laws and constitutions at its pleasure. Besides, the Crown is an integral part of a colonial parliament, whose concurrence is needed in all legislation. The extent of colonial self-government cannot therefore be measured as a matter of law; it rests upon the discretion of the Crown (that is, the British Government) and the Imperial Parliament. It cannot be ascertained by any rule what colonial laws the Queen will veto, or what laws of colonial application will be passed by the Imperial Parliament.

Federation under the Crown necessarily involves a change of some sort in the colonial relations with the Crown. The Australian colonies at present are a group of States, practically self-governing, quite independent of each other, but each directly dependent on the Empire. In each the Crown is a component part of the legislature, and is represented by a Governor who plays the part of constitutional monarch of the colony, subject to a direct responsibility to the Imperial Government. Federation under the Crown means the creation of an intermediate government which, amongst its results, will pick up the threads binding the several colonies to the Empire and twist them into one. But if full effect is to be given to the federal principle, this intermediate government will not be a middle term in the series—*Empire, Commonwealth, States.* That is to say, the series will not be symmetrical; the relation between the States and the Commonwealth will not be the same as that between the Commonwealth and the Empire. The Commonwealth will be a dependency of the Empire; but the States should in no sense be dependencies of the Commonwealth; they should, in accordance with federal principle, be coordinate within their own sphere; each State absolutely independent of the Commonwealth in matters that concern that State alone.

But federal principle also requires that British relations, which from an Australian point of view are external relations, should always be with the federated Commonwealth as a whole, not with the several States. What, then, is to become of the dependency of the States, if they must not be dependent either on the Commonwealth or directly on the Empire? And what room is left for State dependency when State government is confined to local matters alone, if each State is to have absolute control of its local concerns? We are in a difficulty at once; the British principle and the federal principle conflict, and one or other must give way to a certain extent.

It is, of course, obvious that the dependent relation is not a permanent one. The present compromise between dependency and independency is a historical accident, and is to a certain extent anomalous. We are dependent, yet self-governing; we are part of an Empire whose central Parliament occasionally legislates for us, but does not represent us and cannot tax us. It is a relation suitable to colonial infancy—suitable perhaps for many years to come, but one which in the nature of things cannot last for ever. Either one of two solutions may be ultimately possible: (1) Some form of so-called Imperial federation, which, with a federated Australia, would make the series symmetrical; (2) Separation, which would cut the series up. But we have to look at things as they are. We are not ripe for either Imperial federation or separation; we are ripe for Australian federation; and we must look for a system of federation under the Crown which, however imperfect according to strict political theory, will offer a *modus vivendi*. Given the series, *Empire*, *Commonwealth*, *States*, on what system can the functions of government be best distributed among the three with a due regard to federal principle and practical convenience, and without undue meddling with existing institutions?

As between the Empire and the Commonwealth the answer is simple enough. We have only to keep the familiar relation between the Empire and a self-governing colony. Canadian precedent proves the feasibility of this plan. The Governor-General occupies the same position with regard to the Federal Executive and to the British Crown as the ordinary colonial Governor under responsible government; except that his instructions, corresponding with the importance of the dependency, give him—that is, his Executive—a freer hand. Of course the Canadian Constitution does not attempt to set a limit to the Imperial right of intervention in Dominion affairs. It empowers the Dominion Parliament to make laws for the peace, order, and good government of Canada in relation to all matters not assigned by the Act exclusively to the Provincial legislatures; but it does not attempt to prohibit the intervention of the Imperial Parliament, nor to limit the Governor-General's—that is, the Crown's—right of veto. Indeed, to have done so would hardly have been consistent with the dependency of the Dominion.

It is unnecessary to discuss here the question whether the alternative proposition of an elective Governor-General would prove satisfactory. It is enough that, without trespassing on the realm of experiment at all, we can apply an institution which is ready to our hands.

It is with regard to the State Governments that the real difficulty arises. Here we shall find that the example of Canada is not such a safe precedent. The Canadian Constitution, in fact, attempts to make the series, *Empire, Dominion, Provinces*, symmetrical by introducing between Dominion and Provinces an element of *dependency*. The Lieutenant-Governor of a Canadian province is a federal officer, appointed and paid by the Dominion Government, and acting under instructions from the Dominion Executive. He is called the representative of the Queen, but he is only so at second-hand. He is a representative of "The Governor-General in Council," of the Governor-General acting in the capacity of Chief Executive Officer of the Dominion, and therefore with the advice of the Dominion Executive; not in the capacity of representative of the Queen, under Imperial instructions. The Lieutenant-Governor is responsible for his acts to the Dominion Government. Under instructions from the Dominion Government he can veto Acts of the Provincial legislature, or reserve them for the assent of the Governor-General—that is, in effect, of the Dominion Government. In short, the Provinces are to all intents and purposes made dependencies of the Dominion just as the Dominion is a dependency of the Empire. This is altogether opposed to the central principle of federalism, which is that State and Union shall each be supreme within its own sphere, and which makes the courts, as interpreters of the Federal Constitution, the only arbiters between the laws of the State and the Union. The grievance is not merely an imaginary one; the Dominion power of veto, though not frequently used, has been used occasionally when the interest of the Dominion conflicted with the interests of a province, and its use has invariably provoked irritation, sometimes almost a revolution. The whole position of the Lieutenant-Governor is based upon a false analogy, and it is safe to say that Canadian experience warns us against that solution of the problem.

Now let us turn to the "Draft Bill to Constitute the Commonwealth of Australia," which is (if we except the embryo South African Act) the only other example of a Constitution embodying federation under the Crown. It altogether avoids the Canadian error. It leaves the State Governments and State legislation, within the sphere limited by the Constitution, altogether free from the control of the Commonwealth Government. It recognises the federal principle that the State should be co-ordinate with, not dependent on, the Union. But, on the other hand, it does not seem sufficiently to recognise the other federal principle that the bond with the Empire should be through the Commonwealth only, and not through the separate States. It leaves the several Governors direct representatives of the Queen, and directly responsible to her. It does indeed provide (Ch. V., s. 5) that all communications between the Governor of a State and the Queen shall be made through the Governor-General; but this is a matter of official procedure only, not of federal principle. It also provides (s. 8) that "the Parliament of a State may make such provisions as it thinks fit as to the manner of appointment of the Governor of the State, and for his tenure of office, and for his removal from office." Still this does not alter the fact that the State Governor, however appointed, would be responsible directly to the Queen, and that each State would deal directly with the Empire as at present. The seven threads might pass through a single ring, but they would still be seven. Thus one great advantage of federation—that in external relations the Commonwealth should appear one and indivisible, has a startling inroad made upon it, whilst even in purely local matters a measure of Imperial dependence is retained.

The fact is that every suggestion for the representation of the Queen in the States must create anomalies. Between the Canadian plan and the "Commonwealth" plan the possibilities of such representation are exhausted. We are on the horns of a dilemma; the attempt to preserve the external unity of the Dominion lands the Canadian provinces in dependency on the Dominion; the attempt to preserve the independence of the States from the Commonwealth leaves them severally dependent on the Empire, and breaks in upon the external unity of the Commonwealth.

This difficulty arises from the supposed necessity of representing the Queen in the State legislature. Now the question presents itself: Need the Queen be represented in the State legislatures at all? The sole duty of a Queen's representative in a colony, in his capacity as Queen's representative, is to look after Imperial interests; to take care that the Government of the colony shall do nothing which is contrary to the interests or policy of the Empire. But under a federation, the State Government deals only with domestic matters. Imperial interests will be sufficiently guarded by the bond between the Empire and the Commonwealth. Communication between the Empire and the separate States will not only be unfederal, it will be unnecessary; the Imperial Government is not concerned with State matters, and the real difficulty of satisfactorily representing the Crown in the States is due to the fact that the Crown there is wholly superfluous.

To see the truth of this we have only to look at Canada again. The Crown, as I have pointed out, is not really represented in the Canadian provinces. It is only by a fiction that the second-hand royalty of the Lieutenant-Governor can be called "the Crown;" he really represents the Dominion Government. The Imperial Government—the "Crown" proper—has no control over the Provincial legislatures, no veto on provincial laws; its dealings are with the Dominion alone. Here, then, is an instance in which the Imperial Government has foregone its right of representation and its right of veto, without any alarming consequences. If now the Dominion control over the provinces were abolished, leaving them free to do what they chose within the limits of the Constitution, the principle I contend for would be completely established, without one whit detracting from the authority of the Crown in the Dominion. The Provincial Governments, which are already independent of the Imperial Government, would then be independent of the Dominion Government as well; for all practical purposes they would be, within the limits of the Constitution, sovereign Governments in the sense in which an American State is sovereign; whilst the Dominion would remain a British dependency as at present.

In applying the principle to Australia, however, one distinction must be noted between a Canadian province and an Australian State (at least as usually contemplated). By the Canadian Constitution the powers of the Provincial legislatures are strictly defined; they have only the powers specially conferred upon them by the Constitution itself—the residuum of sovereignty resting indeterminately in the Dominion and the Empire. The Constitution, therefore, affords an absolute test of the validity or invalidity of a provincial law; and even in the absence of a veto from outside, the provincial legislature could not attempt to overstep the limits of domestic legislation. It might safely have been declared in the Canadian Constitution that within the limits of the Constitution the provinces were sovereign States.

In Australia, however, the opposite system of distribution of powers finds favour, and is adopted by the Commonwealth Bill. Following the precedent of the United States, it is proposed to define strictly the powers of the Federal Government, leaving those of the States undefined. This would be a difference rather of method than of principle, if the Constitution dealt with the sum total of political sovereignty. But the Commonwealth Bill does not deal with the sum total of sovereignty; it defines the powers of State and Federal Parliaments *inter se*, but leaves both in direct and indefinite contact with the Imperial Government. The Bill itself does not form an absolute test of the validity of a State law. Ch. V. s. 1, provides that "all powers *which at the date of the establishment of the Commonwealth are vested in the Parliaments of the several colonies*, and which are not by this Constitution exclusively vested in the Parliament of the Commonwealth, or withdrawn from the Parliaments of the several States, are reserved to and shall remain vested in the Parliaments of the States respectively." And as the Bill stands, the clause in italics, requiring reference to the pre-existing powers of the State Parliament, is necessary. The Constitution, though conclusive as between the States and the Commonwealth, is silent as between the States and the Empire. Many matters which are not assigned to the Commonwealth are assuredly not left to the States; as, for instance, the distinctly Imperial questions of treaties, the declaration of peace and war, and so forth. The difficulty is this: Where the British-colonial relation of dependency exists, the line drawn between the powers allowed to the dependency and the powers retained by the Empire must be indeterminate. In Canada (if we omit the Dominion control over provincial laws) the provincial powers are exactly defined, and the indeterminate line is drawn only between the Empire and the Dominion, which are in direct contact with one another. In the Commonwealth Bill, the powers of the Commonwealth and the States are clearly defined *inter se*, but they are both left indeterminate as regards the Empire.

This distinction, however, does not affect the principle for which I contend, though it may affect the manner of enforcing that principle. It must, of course, be admitted that it is impossible, short of Imperial federation, to draw a determinate line between the powers of the Empire and those of the Commonwealth. But I see no impossibility in defining the limits between Imperial and State concerns. The two are separated by so broad a belt that it ought not to be difficult to distinguish them, and to draft a clause which would definitely withdraw, or rather withhold, from the State Parliaments all powers of a distinctly Imperial nature. It would then be possible to strike out the italicised part of the clause quoted above, and to leave the *Constitution* the absolute test of the validity of State laws; which would do away with the necessity of an unfederal interference with State Government. If, as

I do not anticipate, such a clause cannot be satisfactorily drafted, the conclusion must be forced on us that, for the peculiar circumstances of Federation under the Crown, the Canadian mode of definition is preferable to the American. This, of course, does not mean that the State powers need be as limited as in Canada; the question is one, not of the extent of State rights, but of the mode of their definition. By a sufficiently careful and comprehensive enumeration, the powers assigned to the Canadian provinces might have been made as large as those reserved to the American States. This may be illustrated by the converse case of Switzerland, where the National powers, though strictly defined as in America, are for the most part fully as extensive as the Dominion powers in Canada.

The whole position may be shortly summed up thus:—In every Federal Government the legislatures, central and local, are subordinate. In a "Supreme Federal Government," such as the United States, they are subordinate only to the Constitution—the Constitution is the sole test of their powers and their limitations. Again, in a British colony the legislature is likewise subordinate; subordinate in the first place to its own Constitution Act, to a definite extent, which is matter for legal determination; subordinate in the second place to the Crown, to an extent that is altogether indefinite. In the case of British colonies federated under the Crown, both kinds of subordination must occur. Federal and State legislatures must of course be subordinate to the Federal Constitution—else there were no Federation. The Federal legislature must also be subordinate to the Crown—in other words, the Crown must be represented in that legislature—else there were no dependency. But the State legislatures need not be subordinate to the Crown—the Crown need not be represented in them at all. From a federal point of view such representation would obviously be out of place; from a British point of view it is unnecessary, as shown by the precedent of Canada. Add to this that the double representation of the Queen would unnecessarily complicate our federal institutions. Superfluous machinery is always better out of the way; and State politics are likely to work more smoothly if Australian Vice-royalty is concentrated in the Governor-General, and the State legislatures are freed from all restrictions except those which can be gathered from the Constitution itself. In short, political principle and practical expediency seem to point to the same conclusion: that in a Federation under the Crown the representation of the Queen in the State legislatures is both unnecessary and impolitic; that the Governor-General is the only necessary, and indeed the only proper, representative of Imperial interests; and that the State Governments should be limited by the Federal Constitution alone, and not subject to outside interference from Commonwealth or Empire.

It does not come within the scope of this paper to discuss what form the State Executive would assume in the absence of a Governor appointed by and responsible to the Crown; but it may be pointed out that no very revolutionary change in our institutions is necessarily involved; no change, indeed, except one which in any case must come sooner or later. Of course, if our Governors are no longer appointed for us we must either appoint them ourselves or do without them. The suggestions (1) to elect the Governor; (2) to work the Cabinet system without a Governor, are both experimental, and need not here be considered. A less violent change would probably meet all requirements. The duties of a Governor, as chief executive officer, are of two kinds: (1) formal duties for which his advisers are responsible and which the political Executive might very well perform of themselves; (2) discretionary duties, for which he himself is responsible, and the most important of which occur at Ministerial crises. These might, perhaps, conveniently be entrusted to the Chief Justice of the colony—who, as it is, is often called upon as Lieutenant-Governor to discharge these functions—and who might perhaps be invested with the title of Governor. Or, if it were thought anomalous for the Governor to be appointed by his Executive, these occasional duties might be entrusted to the Governor-General. True, he would be both an Imperial officer and a Commonwealth officer, and the interference of either Empire or Commonwealth in State affairs is undesirable. But the duties in question are quasi-judicial ones, whose decision requires only political impartiality and an acquaintance with constitutional rules and with the state of parties; and there would perhaps be no serious objection to their performance by the Governor-General, as the highest non-political officer in the Commonwealth.

These details, however, are for the States themselves. The framers of a Federal Constitution have no concern with the alteration of State Constitutions except so far as is necessary for federal purposes. They have only to see that the States have facilities for altering their own Constitutions, and for legislating at their own sweet will, within the four corners of the Constitution. All that the Constitution need do is to define, in some way or other, the exact limits of State legislation, and within those limits to reserve to, or confer upon, the State Parliaments full power to alter their Constitutions and their laws.

In speaking of the Crown so far I have considered only its executive and legislative functions, because it is chiefly with them that my argument need concern itself. But the outline of this paper would not be complete without reference to the judicial authority of the Crown in the colonies. A British self-governing colony has of course full control over the administration of justice within its territory, except that there is an appeal in the last resort to the Privy Council. Federation under the Crown creates an intermediate court—that of the Commonwealth; and it remains to consider what are the proper functions, in such a federation, of the courts of the Commonwealth and the Empire. With this view it is instructive to compare the American and Canadian systems. In America the federal principle of "State rights" is as strictly guarded in judicial as in legislative or executive matters. The decisions of the State courts cannot be reviewed in the federal courts except where a special federal jurisdiction arises—that is, roughly speaking, when a point of federal law is in dispute. In cases which affect only one State or the citizens of one State, the decision of the highest court of that State is final, and there is no appeal to a federal court. Only where the case is one of federal jurisdiction can the Federal Supreme Court be appealed to. In Canada, on the other hand, the Dominion Supreme Court is a general court of appeal for all Canada; it has appellate jurisdiction in all cases arising in Canada, however local may be the interests affected; so that (so far as appears from the Constitution) all decisions of the provincial courts may be reviewed in the Dominion courts. The decisions of the Dominion court may in turn be reviewed by the Privy Council. (A relic, however, of the old provincial isolation remains in the fact that it is optional to pass over the Dominion courts, and appeal direct from the provincial courts to the Privy Council.) The Canadian Constitution, in fact, in judicial as in other matters, models the relation between Dominion and State on that between Empire and Dominion. We may say, therefore, that the American division of jurisdictions represents the strict federal principle, whilst the Canadian system (whether we look at Empire and Dominion, or Dominion and State) represents the dependency principle.

If, then, in a federation under the Crown we strictly followed with regard to the judiciary the rule I have laid down with regard to the legislature—that between Empire and Commonwealth the dependency relation should hold, between Commonwealth and States the federal relation—the result would be something like this: Cases arising within the Commonwealth would be divided into two classes—(1) those which concerned the Commonwealth, (2) those which concerned the several States. The first class would be assigned (in the first instance or on appeal from the State courts) to the federal courts, with an ultimate appeal to the Privy Council. The second class would from first to last lie wholly within the cognizance of the State courts; the decision of the highest State Court of Appeal would be final, and there would be no further appeal to Federal or Imperial courts. In other words, the Crown would be represented in the judicature of the Commonwealth, but not in those of the States; the Crown would no longer be the "fountain of justice" for the States, any more than it would be the fountain of law or of executive authority.

So much for the strict "principle" of the situation. But a principle is only a spirit to exorcise with when it is backed up by solid practical advantages. And there can be no doubt that practical advantage is in favour of having a general Australian or Canadian Court of Appeal. Such a court is technically an interference with State rights; if a dispute is of local concern when at *nisi prius*, and again when in Banco, it must still be of local concern when before the Federal Supreme Court. But this particular State right is not one of which the States are jealous. The independence and impartiality of the bench is so deep-rooted a part of our institutions that no one would dream of looking on the jurisdiction of a general Federal Court of Appeal as interference with State independence. Such a court, without interfering with State independence or the differences of State law which would continue to exist, would confer the inestimable advantage of a uniform system of *interpretation* of the law throughout the Commonwealth.

There should be an appeal, therefore, from the State courts to the Federal Supreme Court; but what about the further appeal to the Privy Council? Here we must distinguish between the Federal Supreme Court as a Court of Appeal for the States and as a court of original jurisdiction. As a court of original jurisdiction—a jurisdiction which would, of course, extend only to matters of federal concern—there would, in accordance with the dependent relation, be an appeal to the Privy Council. But need there be (as there is in Canada) an appeal to the Privy Council (1) from the Federal Supreme Court acting as a Court of Appeal from the States or (2) direct from the State Supreme Courts themselves? Both are questions which expediency rather than principle must decide. Either kind of appeal is technically opposed to State rights, and the first is further objectionable on the ground of multiplicity of appeals. The distance of the Privy Council is another drawback. But, of course, there are arguments on the other side; and the right of appeal would, even if existing, be strictly limited by rules and practice.

The constitutional importance of the appeal question arises in connection with the incidental duties of the courts as interpreters of the Constitution. The Federal Constitution of Australia will probably (unlike the Canadian Constitution) contain provisions for its own amendment by the people of Australia. Though in form an Imperial Act of Parliament, it will be handed to us to do what we like with; and we may rest assured that when once handed to us it would never again be meddled with by the British Parliament except at our express request. Made by Australia, amendable by Australia, ought it not also to be interpreted by Australia, and interpreted (at least as between the Commonwealth and the States) by Australia alone? In the United States the court which interprets the Constitution is a creature of the Constitution. The Constitution is self-sufficing in the matter of interpretation as of everything else. In a federation under the Crown the rights of the Crown must, of course, be subject to interpretation by the Crown itself—that is, by an Imperial court. But the Crown is not concerned with the adjustment of rights between the Commonwealth and the States. Those rights depend upon the Federal Constitution; and the interpretation of a Constitution is equivalent to the text—the interpreters of laws are in a sense and to a certain extent makers of laws. Shall we feel that our Constitution is altogether our own if its final interpretation rest with a tribunal that is outside Australia? Principle here seems to assert itself, and to be backed up by serious risk of friction if its claims be not recognised. It might with advantage be provided that the decision of the Federal Supreme Court should be final in interpretation, as between Commonwealth and States, of the Federal Constitution.

In this paper it has only been possible to deal in general outlines. I have assumed that Federation under the Crown, though an artificial form of government brought about by historical accidents, is yet peculiarly adapted to the present circumstances of some of the groups of British-colonial States; and I have tried to show that though such a Federation involves two conflicting principles—those, namely, of dependency and federalism—these principles may in practice be fairly well reconciled without undue sacrifice of either. I have tried to show that this can best be done by giving the federal principle free play between the Commonwealth and the States, and by giving the dependency principle free play between the Empire and the Commonwealth. At the same time I have not insisted upon a pedantic adherence to any political theory in the face of plain political expediency. Federalism and dependency are both expedient for us, and my object has been to employ these two principles not as fetishes, but as guides, and to look for the most practical means of combining them. My conclusion is (in somewhat Hibernian language) that, like oil and water, they will be best combined by separating them out as far as possible, and by allotting to each its appropriate field; that in the legislative and executive departments this separation may be, and ought to be, complete; but that in the judicial department the same completeness is neither necessary nor desirable. In other words, the authority of the Crown, while retained in the Commonwealth, should be surrendered in the States—surrendered wholly with regard to legislature and executive, and partially at least with regard to the judicature.

6.—THREE SYSTEMS OF POLITICAL ECONOMY.

By ANDREW GARRAN, M.A., LL.D.

It has been remarked that theories and systems have been moulded unconsciously by contemporary conditions of society—that the great thinkers who have formulated these systems have absorbed and reproduced the spirit of their age without recognising the force that was making an impress on their minds, and that therefore to understand any system thoroughly, we should understand the age in which it originated, and the dominant and most obtrusive forces of that age.

There is some justification for this doctrine, if we consider the different points of view from which the whole question of political economy has been viewed. We are now in a position where, looking back upon the past and out upon the present, we can mark off distinctly three different systems, based on three different class interests. Economically considered, our modern society may be regarded as divided into three classes. There is the land-owning class that lives mainly on rent, the trading class that lives on profit, and the hand or brain-working class that lives on wages or salary—that is, on the payment for work. These three classes, though distinct enough to be considered separately, shade off into one another in practice. The landed class sometimes farms its own land, and sometimes engages in trade, either through the medium of companies or otherwise; and both landed and trading classes have scions of their families who work for salaries. Economically considered, the Lord High Admiral is a wage-getter who works for his living and has had to go through his apprenticeship just as an ordinary artisan does. The wage-getting class, though it has not too much opportunity for it, likes to own land when it can, and through the agency of building societies and other helps has done a good deal towards securing freehold homes. It is to be regretted that it has not done more.

But though the three classes named run into each other, they are each well marked and have their special characteristics. The members of each look out upon the social system from their class point of view, and in their meditative hours and in their colloquies with their colleagues they instinctively shape their system of political economy to suit their own interests.

In Europe the feudal system made the landed aristocracy socially and politically supreme; and altogether apart from profit, to own land became an object of social ambition. In England at one time none but land-holders were summoned to the King's Council, or had any political position. This monotony was only tempered by the position of clerics, who for a time had the learning all to themselves, and whose services for clerical work were therefore essential. Even in England till lately, a vote for the county was thought to be something superior to the vote for the borough, and the successful manufacturer did not consider himself socially set up—or at least his wife did not—till he had bought a country seat and worked himself into the society of the county gentry. The ascendancy of the landed interest in England had a long duration, and yet there is no definite treatise working out a coherent system of political economy on the basis of the supreme importance to society of the land-owning class. But the doctrine shows itself in the laws, and the legislation of the country, and carries abundant traces of the fact that for centuries the landed class made the laws, made them in their own interest, and made them on the fundamental principle that the landed interest was, and ought to be, supreme. The law of primogeniture, the law of settlement, the Statute of Labourers, the laws of Elizabeth regulating wages, the abolition of the feudal claims, the enclosure of commons, the priority of the landlord as creditor, are some of the indications of this tendency. The fundamental, even where unexpressed, axiom of this system of political economy is—make the land-owners prosperous, and all classes will be prosperous with them.

Arthur Young was no systematic economist. But he was the great describer and panegyrist of English landlordism. Professor Thorold Rogers, referring to his writings, says—

"His entire sympathy is with agricultural production. Everything must lend itself to this result. The labour must be cheap, whatever it cost in penury to the workman. The produce must be increased by every effort of ingenuity and skill. The energies of the farmer must be stimulated, and his ignorance and sloth cured by a rack-rent lease. The continuity of these beneficent processes must be secured by prodigal bounties on the exportation of agricultural produce, and judicious restraints on its importation."

In course of time the produce of the soil found a rival in the produce of hand labour. The towns grew slowly, and the traders grew slowly with them, and they often had to pay a heavy tax to the feudal lord; but such was the vitality of civic industries that their growth was irrepressible. For several centuries manufacture was, as its name implies, merely hand labour, the machine playing only a very subordinate part; and, so limited, production was necessarily costly, and the interchange part of trade was kept down accordingly. The great propulsive event that made manufactures advance by leaps and bounds was the invention of machinery, and this took place principally in England. First in importance was the invention of the steam-engine. Watt aimed at draining the Cornish mines; he drained a great deal more. Then, within a very short period, came the marvellous improvements in the machinery for textile industry; and then the cheaper methods for working iron ore. In two or three generations the relative populations of town and country, and the relative wealth productiveness of agriculture and manufactures, was entirely changed. Goods were enormously cheapened, British commerce was enormously expanded, and its mercantile navy was seen on every sea. The centre of gravity of English society was altered, and the change in the possession of political power had to follow the change in wealth production.

The great writer who gave expression to the wants of the new and rapidly growing industry was Adam Smith. His great book, "The Wealth of Nations," was published just as England was entering on her new career. Although stimulated to a large degree by French writers, he wrote under the inspiration of the conditions around him in Scotland and England. He gave voice to the wants of the new school, and especially to its great want—freedom of movement. Governments had always been possessed with the idea that they could do something for industry, and they certainly had done something for land-owners. Adam Smith pleaded for freedom of trade and the abolition of restrictions. His work was the hornbook of successive generations of statesmen, and few closet philosophers have ever had so direct an influence on Budgets. All the legislation that tended to liberate trade proved a success for its special purpose, for the liberated trade answered by immediate expansion. The idea more and more took possession of people that trade—including in that expression both manufactures and interchange—was the great interest of the country; that the one thing needed for the prosperity of the nation was to look after trade, and that all other interests would benefit in its wake. The great contest between the trading class and the older possessors of political power took place during the battle over the Corn Laws, when trade asserted its supremacy.

And now once more the centre of gravity is shifting. We find ourselves in an age when the whole trading class is condemned and ridiculed as bourgeois. The factory system, while it has realised its great aim of cheap production, has developed special social evils of its own. In this world there seems to be no such thing as an exclusive blessing. Every advantage gained has its shadow behind it. Factory laws in England did a great deal to prevent the overwork of women and young children, and the education laws secured to all children the power to read and write. But that has dealt with only part of the difficulty; the greater and more serious work remains behind. The whole adult male class is claiming, with more or less clearness and firmness, some protection against excessive competition, and some guarantee against want of work. A wholly new system of political economy is being formulated, and it is being shaped exclusively from the point of view of the receiver of wages—a point of view wholly different from that of the land-owner or that of the trader. Marx has done the most to give form to the complaint of the worker and to argue that he is exploited and robbed by his employer. But it cannot be said that the new system is definitely embodied in any one treatise, for it occupies all the intermediate ground between a system of restrictions on existing abuses and the establishment of thorough-going socialism. Still the main idea that interpenetrates the writings of all radical reformers belonging to the wage-getting class is that their class is the only one that needs to be considered. Let the Government do full justice to the workman, and then there will be no need to care for anyone else. Socialism goes so far as to say that there need not be anyone else, and indeed that there ought not to be—that Government ought to extinguish every employer and every form of capital, and prohibit every kind of saving, and that all members of the community should be co-equal workmen working for State wages.

The factory system, though it destroyed the system of home manufacture, and in one sense diminished the personal liberty of the worker, in another sense prepared the way for his greater political liberty, because men in aggregation learned to feel the power of union, and the mental collision proved a high political education. The factory workers claimed and obtained a share in the suffrage, and their theory of political economy is not the dream of a philosophical student, but the demand of men who have votes to back it.

We have thus three distinct systems of political economy, each representing a class interest, each shaped from a different point of view. The one rests on the assumption of the supreme importance of the land-owners, the next on the supreme importance of the traders, and the third on the supreme importance of the receivers of wages. Is it necessary to say that a complete system of political economy will take cognisance of them all and do justice to each? Until socialism is established the importance of the employing and commercial class cannot fail to be recognised, while the prosperity of the landed class is intimately interwoven with the general well-being. Indeed, it is worthy of note that in these colonies our present financial condition is forcing us to recognise, more than we have done of late years, how the productive use of the land lies at the basis of our prosperity. On every hand we hear the cry raised that the people are not only to be put on the land, but that everything that the Government can legitimately do is to be done to make their use of the land profitable. The cry is, Let them have cheap freights, cheap money, and let them be helped to the highest price for their produce. This cry has no feudal ring about it, because the land-owners whom it is thus sought to help are not large but small ones. Still, there is a growing feeling, produced by our conditions, that to recover from our deep depression we must get more wealth out of the soil, that the land only is our great resource, and that if we could but make every occupier in the country prosperous, we should soon bid good-bye to bad times. We are very far, therefore, from having outlived the theory which bases the prosperity of the community on the prosperity of the occupiers of land. We are crying out for a more numerous landed class and a more prosperous landed class, and this cry is begotten of our adversity.

7.—SOME FACTORS OF FEDERATION.

By W. McMILLAN

To a close observer of the proceedings of the Federal Convention of 1891 it must have been apparent that the spirit which dominated the earlier speeches and proceedings of that body was of a distinctly provincial character. But it was equally observable as time went on that by friction of opinions, mutual consultation, and a wider knowledge a process of moulding began which ultimately evolved that truly federal spirit which afterwards found concrete form in the

Commonwealth Bill. This result, we trust, may fairly be considered as prophetic of the attitude of that Parliament which will be called into existence whenever the Constitution Bill is finally approved by all the people of Australia.

But this very narrowness of view, which is still the great stumbling-block in framing a Constitution, will also be, if not carefully surrounded by reasonable safeguards, an imminent danger during the earlier period of our new national life.

A great deal of discussion has taken place upon many points of constitutional machinery which is inevitable, no matter what may be the exact details of the future Federal Government. These are matters upon which I do not intend to touch in this paper. I desire, however, to deal with some of those problems which will have to be considered sooner or later owing to the peculiar character of Australia as an island continent of vast dimensions, with every variety of climate from the extreme tropical to the extreme temperate; more especially as I consider this phase of the subject affects in a very far-reaching manner the future destiny of that colony in whose metropolis this paper will be read. Perhaps the best way of dealing with this question will be to contrast the exact conditions of Australia, geographically and topographically, with the conditions of the two great English-speaking countries from which, in this problem of Federation, we must draw a great deal of our political light—I mean, of course, the United States of America and the Dominion of Canada. The points of agreement are too obvious to mention. Let us first contrast the United States with the Dominion of Canada. The federation of both is in one important point similar, although not in the same degree. In each case there are two seaboards with not merely separate States on the littorals of both, but there are also intermediate States which form a congeries of States interdependent upon each other. Of course this aspect of the American Federation is much more accentuated, as it is divided into fifty States and territories apart from Alaska, whereas Canada at present is only divided into about eight different provinces. But here the points of likeness end. While Canada may have great extremes of climate, the whole of her vast territory is essentially favourable to the development of the European race. No colour question need ever enter into her politics, and she is thus altogether free from one of the disturbing factors of future civilisation.

America, on the contrary, is divided, like Australia, into temperate and tropical, the latter having developed an industrial life essentially different from the former. But in America one great phase of the tropical question has been solved. The labour population is there, with equal rights and privileges, as the result of one of the bloodiest wars of history. The new difficulties which the evolution of the future will unfold with regard to this essentially alien race will be matters for another generation.

Now let us turn to the main geographical features of Australia. There are, of course, two main divisions which determine to a large extent the habits and occupations of the people. First, there is that large portion within the direct influence of a seaboard extending over 8,000 miles; and then there is that vast interior in which the rainfall is very limited, and in which the occupation of the people must be for an indefinite period confined to pastoral pursuits. But the first division divides itself into two distinct parts, as in the case of the United States—the tropical and the temperate—in which the habits and occupations of the people and the conditions of life must differentiate very widely. Now, the question which naturally arises is—In view of these various conditions, if the authorities who originally divided these colonies had had some prophetic vision regarding the federal necessities of the future, would they have decided to cut up this continent into such large territories, made up relatively of such incongruous parts, without having made provision for their reconstruction upon more scientific lines, as a congeries of States, having in each an area which in size was somewhat in proportion to the reasonable conditions of a self-governing province, and in which the inhabitants were bound together by similar local sympathies and mutual interests.

Now, although all federations are constructed in view of existing conditions, still it may be just as well to examine what under an ideal set of circumstances would form the most lasting elements of a federal community. We are not now dealing with a number of ancient States differing in race, in language, and in national affinities; we are dealing with a population of a practically homogeneous character; and while the various colonies, even in their short existence, may have differentiated slightly in their habits and in the character of their industrial life, there is still no alien element preventing the citizen of one colony from changing his abode and casting in his lot with the citizens of another colony. We are therefore in a position to discuss all such matters in a liberal spirit, and to retrace our steps if such action is necessary to secure the solidity and the durability of our future national Government. We may construct on paper the most magnificent and ideal Constitution; we may give to that Central Government powers which will enable it theoretically to dominate our ports and to hold our military organisation in its hands; but all this would be quite unavailing if the various parts which form the federation are so unscientific in their relative proportions that one or two may dominate the rest, so that disintegration instead of union may meet us face to face in the hour of national danger.

To return, then, to the ideal Federation. It should, if possible, be composed of States in which each is possessed of an area limited to the necessities of autonomous government, and in which the natural conditions with regard to climate and rainfall are sufficiently similar to determine a compact territory united by local bonds of common interest.

With the exception of Victoria and Tasmania, none of the other colonies realise these conditions. New South Wales has its coastal territory and its far interior, with absolutely dissimilar interests and with enormous cost of government. Queensland, South Australia, and West Australia are each composed of the three distinct parts to which I have already referred—temperate, tropical, and interior—all with divergent and in many respects utterly incompatible interests.

Now, by the terms of the Federal Convention Bill, under sections 4 and 5, Chapter VI., it is clearly laid down that the boundaries of no State shall be altered, and that no new territories shall be cut out of the existing States without the consent of their respective Parliaments.

This is probably a necessary provision, in view of the extreme local jealousy and provincialism which at present exist. But it is just as well that those who will be called upon to deliberate on these great questions, when once Federation has become an accomplished fact, should even now begin to study the problems of the future. The federal tariff must be the first great question of the Commonwealth Parliament, but there is no doubt to my mind that the next great question should be the complete alteration in the territorial lines of the present States, and the formation of a number of territories admitted to political privileges under special provisions, especially in the vast interior, which forms probably one-half of the area of all Australia.

While not desiring to reduce for one moment the governing powers of the provinces to the status of what is known as local or county government, I think it cannot be too strongly insisted upon that each State should be strictly confined to an area of such dimensions as to prevent the undue preponderance of one or of several becoming a menace to the liberty of the others, or a cause of future disintegration. But when all this is done, it still leaves untouched the great question which must sooner or later be an absorbing one in the colony where this paper is being read—I mean the delimitation of the tropical part of Australia and its special labour conditions, as contrasted with the other portion, in which it is acknowledged that there is no necessity for any alien intermixture. In the Commonwealth Bill, in section 52, Chapter I., Part V., in the list which enumerates the "Powers of the Parliament," we have "Naturalisation and Aliens," and in section 53, under the head of "Exclusive powers of the Parliament," subsection I., we have the following:—"To make laws for the affairs of people of any race, with respect to whom it is deemed necessary to make special laws not applicable to the general community." Now, this opens out a very interesting and vitally important question with regard to the whole of that vast territory which forms the Northern portion of Queensland, South Australia, and Western Australia—the question of the development of the commercial, industrial, and social life of the inhabitants of that region. I think it may be taken for granted by every sane person that there would not be much difficulty in drawing a line from east to west, north of which it is quite impossible to develop the various resources of that great territory by the aid of European labour. We have to decide whether it must be left for all time to be occupied by the white man for the sake of a few scattered goldfields where the lust for wealth will allure large spasmodic populations for a brief period, no matter how appalling the mortality; or whether, on the other hand, it shall be, under properly regulated labour, one of the richest and most beneficent sources of man's wealth and comfort known on the habitable globe. But the growth of population in these territories must be comparatively slow, and the proportion of white population must always be small as compared with the States enjoying the more salubrious climates of the South. To those in the North, the climate practically fixes the conditions of their industrial and social life, and these conditions must more or less reflect upon the political ideas of the people, giving them a more conservative tinge in contrast with the essentially democratic principles of the South. From this it is clear that in any Federation of the future which can hope to be of a durable character, there must be large concessions made by the democratic spirit of the South to the very different social and political ideas which must of necessity dominate the North. It is obvious, therefore, if my argument is a sound one, that, with regard to the new Federal Constitution, there are two all-important and essential conditions which should be carefully weighed by the people of Queensland:—

1st. The reconstruction of the boundary lines of the various colonies, together with their further subdivision; and

2nd. The question as to what extent, under what will practically be an unalterable and fundamental law, they will allow the votes of populations with whose industrial life they have nothing in common to dominate their whole future destiny.

To me the careful consideration of the future durability of the Commonwealth *as a whole* is of much greater moment than any feeling of affection for New South Wales or any other of its component parts. Of two things I am perfectly certain—that if the present lines of territory are not materially altered, the excessive provincial strength of one or two States, with corresponding jealousy and distrust on the part of the others, will rend the fairest constitutional fabric to atoms; and I am further convinced that if there is any undue attempt in this fundamental law of the Constitution, by the democracies of the South, to apply their own rigid rules of industrial life to the great and undeveloped conditions of the North, there must be sooner or later such a superhuman strain that no Central Government will be able to maintain the Union. With all the circumstances in our favour, separated from outside influences through our island character, and inhabited by essentially the same race, there are still in many respects more dangers of future disintegration, even after the federal idea has been achieved, than probably either in the case of the United States or Canada. There are many other factors connected with the future problems of Federation to which I should have liked to refer, but the pressure of business and politics prevents me.

I would just like to mention three things, which I trust will engage the immediate attention of the Commonwealth Parliament as a means of cementing the commercial and social life of the various peoples.

First, a railway connecting the present Queensland system with the great harbour of Port Darwin, which must ultimately dominate the North as the key to the commerce of the East, as Sydney now dominates the East as the key to the future commerce with America.

Secondly, a line of railway connecting the system of South Australia with the capital of Western Australia; and

Lastly, a Federal Naval School for the training of boys both for the commercial marine and the Royal Navy, so as to preserve, or I might rather say revive, that spirit of marine enterprise which lies at the basis of all English pluck and adventure, which our kinsmen in the United States of America seem to have lost, and which we ourselves will soon lose altogether, if we continue to depend upon aliens for the manning even of our coastal fleets.

With the commerce of the West and the commerce of the East, which must sooner or later be ours, it is absolutely essential that we should be a great shipbuilding and seafaring people all along our enormous coastline of 8,000 miles. With our commerce, with magnificent agricultural areas along our coasts, our coal, our iron, our gold, and every other known metal scattered through our territories, and with our vast interior for pastoral purposes, which some day, by a scientific system of irrigation, may be turned into a garden, the future Commonwealth of Australia, if properly constructed, and laid upon enduring lines, with a truly federal conception of the various interests and necessities of its future vast populations, will yet build up for itself a peaceful and enduring fame as one of the greatest factors of the world's ultimate civilisation.

8.—PRIMITIVE THEORIES OF POLITICAL DUTY.

By W. JETHRO BROWN, M.A., LL.D., Dean of the Faculty of Law, University of Tasmania.

9.—SOME ASPECTS OF THE LAND QUESTION.

By JOHN QUICK, LL.D.

10.—THE SOCIAL TREND: WHAT IS COMING?

By Rev. HORACE F. TUCKER, M.A., Dean of Melbourne.

11.—LAND AND FINANCE.

By H. L. E. RUTHNING.

12.—INTERCOLONIAL FREE TRADE AS AFFECTING QUEENSLAND AGRONOMY.

By DANIEL JONES.

13.—LABOUR, THE SOCIAL PROBLEM OF THE HOUR.

By E. F SCAMMELL.

14.—LABOUR AND CAPITAL.

By A. J. OGILVY.

15.—PRIVY COUNCIL APPEALS AND THE AUSTRALIAN COLONIES.

By G. B. BARTON, Barrister-at-Law, Sydney.

16.—THE TAXATION OF LAND VALUES.

By H. B. HIGGINS, M.A., LL.B.

17.—THE SOCIALISM OF THE NEW TESTAMENT.

By Rev. WALTER ROBERTS, M.A.

18.—INDIVIDUAL AND FAMILY SETTLEMENT ON LAND.

By T. G. SYMON.

AGRICULTURE.

1.—HOW TO GROW FRUIT.

By ALBERT H. BENSON, M.R.A.C., Fruit Expert to the New South Wales Department of Agriculture.

The subject of my paper, "How to Grow Fruit," is one that I expect most persons will consider altogether outside the range of subjects usually dealt with by an Association for the Advancement of Science, more especially so as I purpose treating it mainly from a practical standpoint.

I shall, however, endeavour to show that the progressive fruit-growing of to-day is by no means unworthy of being called a science, and that the wide-awake and up-to-date fruit-grower is largely dependent on the practical application of scientific knowledge for the profitable and successful carrying on of his business.

There is no branch of agronomy in which science and practice are more closely connected than in that of fruit-growing. Every operation of the fruit-grower is or should be carried out on scientific lines; and the best methods of propagation, pruning, cultivation, manuring, treatment of diseases, and preservation of fruit when grown are all directly or indirectly the result of scientific research.

The services of the agricultural chemist, pathologist, entomologist, botanist, and scientific agriculturist are also being continually called for to assist in developing one or other of the many branches of the fruit-growing industry.

The fruit-growers of these colonies are not as a rule, I am sorry to say, yet fully alive to the important part that science plays in progressive fruit culture; and that, therefore, taken as a whole, they are very far from knowing how to grow fruit.

By growing fruit I do not mean growing rubbish, but the production of an article of the first quality that will be a credit to the grower and that will meet a ready sale in any market.

No doubt our growers do produce fruit, and in large quantities too, but is it grown to the greatest perfection, and of the highest quality? Unquestionably not; for though there is a certain percentage of first quality fruit produced, there is a very much larger amount of rubbish consisting of worthless and inferior varieties, undersized and diseased fruit, which is far from being a credit to our fruit-growers. For many years past fruit-growing has been a very paying business, and growers have in many instances amassed a considerable fortune from the returns of their orchards, but now, with a greatly increased production and very much lower prices, the old easy-going methods of fruit culture are by no means as profitable as they were a few years since, and the fruit-grower of to-day in order to be successful in his business must keep up with the times, call in the aid of science to his assistance, employ improved methods of culture, grow nothing but first-class fruit, and work not only with his hands but with his brain as well. Hitherto fruit-growing in these colonies has been largely conducted in a more or less happy-go-lucky manner, the ease and rapidity with which fruit trees are grown, and the abundant crops they bear, even with indifferent attention and cultivation, being mainly accountable for the unsatisfactory and dirty condition in which so many of our orchards are kept. Now, however, what with much lower prices and the large amount of loss that is caused by the ravages of insect and fungus pests, fruit-growers are beginning to devote more careful attention to their business. New and improved methods of cultivation are being slowly adopted; the important questions of manuring and drainage are being studied; worthless varieties of fruit are either being taken out or worked over with high-class fruits; and diseases are being fought, in many cases with very beneficial results.

It will thus be seen that a great change is slowly taking place in our fruit industry, and that though its effects are not yet very apparent, it is only a question of time when the obsolete method of fruit culture commonly adopted by Australian fruit-growers will become a thing of the past, and fruit culture will be raised to its proper level, and that is a position second to no other branch of scientific agriculture.

Having now shown the position that fruit-growing should occupy by right, I will try and show in as concise a form as possible how this position may be attained, and in order to do this I purpose dividing my subject into four branches, as follow:—

1st. How to Start an Orchard.
2nd. How to Plant and what to Plant in an Orchard.
3rd. How to Look after an Orchard.
4th. How to Utilise and Market Fruit.

HOW TO START AN ORCHARD.

The first consideration of anyone about to plant an orchard is naturally—What shall I plant? and having decided on the kind or kinds of fruit to be grown, the second consideration is—Where shall I grow them?

It is impossible to devote too much attention to these primary considerations, as the ultimate success of the orchard depends largely on its being properly started. No fruit should ever be planted in an unsuitable soil or situation when there are any quantity of suitable sites available, even in our oldest fruit-growing districts; neither should any fruit be planted that will not grow to the greatest perfection, except a small quantity required for home use, or to supply a purely local demand, as it will not pay to attempt to grow any fruits in quantity that can be produced elsewhere, under more favourable conditions, of a superior quality and at a lower rate.

In selecting a site for an orchard, climate, soil, situation, drainage, rainfall, shelter, water, and market facilities have all to be taken into consideration, but their relative value depends largely upon the class of fruit that it is proposed to cultivate; thus water, which is of paramount importance in the dry interior, is only of secondary consideration on our tropical and semi-tropical seaboard, with its usually regular and heavy rainfall.

As to climate, we have anything that one may wish for, from tropical to temperate, and as a consequence we can grow to perfection within these colonies practically the whole cultivated fruits of the world, in many cases the fruits grown here being superior, both in size and quality, to those of the countries from which the fruits were originally obtained.

The soils best suited for fruit-growing are deep friable loams or sandy loams, having an open subsoil, and thus possessing good natural drainage. These soils are easily worked, and retain moisture well under a thorough system of cultivation. Though not necessarily very rich soils, yet when of sufficient depth they contain as a rule a sufficient amount of plant food for the proper development of most fruits, and should they be deficient in any essential ingredient, they respond well to the application of manures containing that ingredient; in fact they are the best matrix with which we can have to work. Heavy clay soils, or loamy soils having an impervious clay subsoil, are unsuitable for fruit culture, as they are expensive to work, bake and crack badly in dry weather, and retain stagnant water around the roots of the trees planted in them.

The best situation for an orchard is a gentle slope to the north-east, with a natural shelter from the prevailing heavy winds.

All soils that are without an open or porous subsoil require draining before they are suitable for growing fruit, as there is no more frequent cause of orchards failing than the want of drainage. The accumulation of stagnant water about the roots of the tree and the want of aeration in the soil are also the primary causes of many of the worst diseases of fruit trees. The question of drainage is, therefore, of the first importance, and no soil is suitable for fruit culture unless it is thoroughly drained—either naturally or by artificial means.

A good shelter against heavy winds or against the hot, dry winds of the interior is also of great importance, and where it does not exist naturally in the shape of a belt of timber or a background of higher land, then it will always pay to provide an artificial shelter, say, a double or triple row of any quick-growing trees that are suited to the district.

In the dry interior, first secure your water. The land, as a rule, is all right, but water is the first consideration, as it is impossible to grow fruit successfully without it. With water, however, on suitable soil you can grow anything that is adapted to the climate.

Having decided on the site for the orchard, the land is prepared for planting. If uncleared virgin soil, which is as a rule the best to choose, the land will have to be first cleared and the stumps and roots taken out to a depth of at least 18 inches. When this is done the land is ploughed to a depth of 10 to 12 inches if the soil is deep enough, but in no case should the subsoil be brought to the surface. The plough should be followed by a subsoiler that should go as deep as the roots left in the ground will permit, as this will tend to sweeten the subsoil and to break up any hard pan that may be near the surface.

After ploughing, the land should be allowed to remain for some time in as rough a state as possible, so that it may be well exposed to the action of the sun and air and become sweetened. If the land is naturally sour, owing either to the presence of stagnant water or of large quantities of decaying vegetable matter, it will have to be first sweetened, and this is done by subdrainage where stagnant water is the cause, or by the application of fresh lime at a rate of 1 to 3 tons to the acre when it is necessary to directly neutralise the free acid present in the soil.

When sweetened the land should be well harrowed and cross-harrowed with heavy breaking harrows so as to level the ground and completely break up the original furrows. The land is then cross-ploughed and again worked down fine, after which it is ready for planting. In preparing the land for an orchard always do so thoroughly; rather do one acre well than two acres badly, for though it may be more expensive in the first place, it will be much more satisfactory and pay better in the end.

HOW TO PLANT AND WHAT TO PLANT IN AN ORCHARD.

Before planting an orchard the first thing is to see that the ground is well laid out, so that when the trees are planted the rows will be straight in every direction, as nothing looks worse than a badly planted orchard. Correct planting is also a great assistance to cultivation, for when the trees are planted anyhow it is impossible to do as much or as good work with horse cultivation as when the trees are planted symmetrically. The orchard may be laid out in the manner that is considered best, opinion differing somewhat in this respect, the systems usually in vogue being the square, hexagonal, quincunx, and alternating squares. As a general rule I prefer planting in squares; the distance between the rows being the same both ways, and I consider an orchard so planted the easiest to cultivate. Many growers, however, prefer the hexagonal system, where the trees are all equidistant from each other, but the distance between the rows is less than the distance between the trees in the row in the proportion of 17·407 to 20. Planting in hexagons certainly allows of more trees being grown to the acre than planting in squares, the distance between the trees being the same in both cases; but this is a questionable advantage, as in my opinion we plant far too many trees to the acre as it is. Planting in hexagons is certainly an advantage in exposed situations, as the trees when so planted form a better natural protection against heavy winds than when planted in squares, as the trees occupy the whole of the ground, and there are no avenues for the wind to go through, the outer rows thus protecting the inner ones.

The quincunx is a system of planting in squares with a tree in the centre of each square. The idea is to remove the centre tree when the orchard becomes too crowded, and leave the orchard in squares.

Planting in alternating squares is a system whereby large-growing and late-bearing varieties, such as walnuts, chestnuts, &c., can be grown without giving up the whole of the ground for the first few years to their culture. Thus the permanent trees are planted in squares, say, 50 feet apart each way, each square being divided into four smaller squares of 25 feet apart each way, the smaller squares being planted with quicker-growing fruit trees, which bring in a return whilst the other trees are growing, and which are removed when the whole of the ground is required for the permanent trees.

Whatever system of planting may be adopted, the following particulars should always be carefully attended to:—

Never plant deeper than the young trees were planted in nursery; too deep planting kills many trees.

Never dig a deep hole where the land has an impervious subsoil; it is simply making a basin to hold stagnant water, which sooner or later will kill the tree.

Never place any manure round the roots when planting. If it is desirable to use any manure, mix it thoroughly with the soil before applying.

If the land has been properly prepared, and is in good order, there is no necessity to dig large holes; the holes should be just large enough to allow the roots to be well spread out.

Always keep the centre of the hole rather higher than the sides, so that water may drain from and not towards the trunk of the tree.

Place a little fine top soil over the roots, and press the roots firmly into it; then fill up the hole carefully and firmly, and the tree is planted.

Always plant yearling trees when obtainable. They bear the shock of transplanting better than two-year-old trees, and they usually make stronger and more symmetrical trees. Carefully trim the roots before planting, and cut the top back hard when planted. If you do not cut back at planting, the result will be a badly grown, straggling tree that will make anything but a vigorous growth; but by cutting back hard you will obtain a strong and vigorous growth, and that just where it is wanted—namely, the trunk and main branches—for unless you start your tree with a good foundation you will never build it up into a strong and well-grown tree. The height at which to head the tree should not exceed 2 feet in any case; and where the climate is very hot and dry, 1 foot is better than 2, and this has been amply proved by Californian experience.

Do not plant your trees too close together. Twenty feet apart is the least that should be allowed for any fruit; and many varieties are much better at 25 or even 30 feet apart. Though the returns are not so large at first as when the trees are planted closer together, the orchard will last longer and pay better in the end, in addition to which it is much easier cultivated, as there should always be ample room for the use of horse-power in orchards both for cultivating the ground, spraying the trees, and gathering the crop.

What to plant in an orchard depends entirely upon the climate; and, as previously stated, nothing should be planted that will not grow to the greatest perfection; and not only this, but no fruit, except it is of especial merit, should be grown. All inferior fruit should be set aside, and only a few varieties—and these the very best—should be planted, as one of the greatest mistakes made by our fruit-growers is the planting of far too many varieties, many of which are practically valueless. The insane habit of crowding every variety of fruit that can be obtained into one orchard, which is so frequently met with, cannot be too strongly condemned, as it is to this cause more than any other that the large amount of worthless and inferior fruit which is flooding our markets and injuring our fruit trade is due.

When the soil and climate grow such fruit as prunes and apricots to perfection, grow prunes and apricots. Where late apples of fine quality and good keepers grow, by all means grow late apples; and where citrus fruits grow to perfection, grow citrus fruits. Don't try and grow oranges where you should grow apples, or prunes and apricots where you should grow oranges—it won't pay; just stick to what your soil and climate will grow best. There is more money in that than in trying to grow fruits under unsuitable conditions.

When planting an orchard, don't plant fruit that is only valuable for consuming fresh, unless it possess special qualifications, such as earliness or good shipping qualities, as when the supply is in excess of the demand the excess cannot be profitably absorbed by canning, drying, jam-making, or otherwise, and as a consequence the market becomes glutted and prices fall to such an extent that the fruit cannot be produced for the price it realises.

Plant fruits that, in addition to being of first-class quality fresh, are also valuable for canning, drying, or jam-making, so that should one market fail there are others to fall back upon, and you will thus have several outlets for your fruit in the place of the one which is now so easily overdone.

HOW TO LOOK AFTER AN ORCHARD.

I stated, when speaking about preparing the soil for an orchard, that it was far better to do one acre well than two acres badly, and in managing an orchard this is equally true. Never handle more than you can manage, but whatever quantity you work let it be done thoroughly. There is no branch of agronomy that requires more careful or thorough work than that of fruit-growing; neither is there any branch that will pay better for extra care and thorough attention. Rest assured that, if fruit-growing will not pay with thorough attention and cultivation, it most certainly will not pay with neglect. Therefore I say to all those who may think of going in for fruit-growing that, unless you make up your mind to go in for it thoroughly—which is the only way to grow high-class fruit, which alone will pay—you had better leave fruit-growing alone, and take up some easier business. Don't run away with the idea that all you have to do is to dig a hole in the ground, stick a tree in, and that it will want no further attention, or that when a tree has come into bearing all you have to do is to gather the fruit and send it to market. If you do you will, in the words of our American cousins, "be badly left," and will come to the conclusion that fruit-growing is not by any means the simple and easy business you thought it was.

If an orchard is expected to pay it must be properly looked after, and to do this it is necessary in the first place to keep the land in the highest state of cultivation. The land must be well and deeply worked, not scratched, and every weed must be eradicated. No man can afford to grow weeds and fruit in the same ground, as every weed is robbing the trees either of moisture or plant food which are required by the trees to properly develop their crop. Thorough cultivation is also the best and only satisfactory method by which moisture may be retained in the soil; therefore it is of the first importance in our drier districts. Plough the orchard during the winter, but use nothing but the cultivator during the summer. If you want to retain moisture, stir the land often and stir it deeply, but don't turn it over, and this will prevent the loss of moisture by surface evaporation to a very great extent.

Use improved implements of cultivation. In these days of keen competition, hand labour is altogether out of the question, as it will not pay to do anything by hand that can be done cheaper and better by horse labour.

The ploughing in winter is best done by one, two, three, or four furrow digging ploughs of the Avery, Oliver, or John Deere type, as they are the easiest to handle, and do the best work; and the summer cultivation should be done by one or two horse cultivators; the latter for preference, as they do the work cheaper and better.

Never allow the land to become caked after a rain in summer; always run the cultivator over the ground as soon as it will carry the horses, and the greater portion of the rain that has fallen will thus be conserved for the trees' use which would otherwise be lost, as surface evaporation takes place very rapidly in warm weather when there is an unbroken crust on the land.

In order to grow good fruit it is also necessary that the trees shall be properly pruned, not only that the tree may be made to grow symmetrically, and to produce the bulk of its crop along the main branches instead of at the extremities of the limbs, but also so that the tree shall not be allowed to bear more fruit than it can bring to perfection. Though the number of fruit on a tree can be greatly reduced by judicious winter pruning, it is often necessary, especially in the case of stone fruits, to thin heavily, as small stone fruits are generally of very little value, and, in addition to being almost unsaleable, when allowed to remain on the trees in large quantities they are a very severe strain on the trees' energy, as every stone contains the germ of a young tree, to form which takes much more out of the tree and soil than growing a heavy crop of large, fleshy fruit. When trees are shy bearers, summer pruning and root pruning will cause the formation of fruit-bearing wood. Winter pruning forms wood; summer pruning forms fruit.

Always head your trees low. The advantages of low heading are: Protection of trunk and main branches from sunburn; ease in gathering the fruit; less liability to damage by heavy winds; increased facilities for using the horse in cultivation, and ease in pruning, spraying, &c.

Head low, giving the main limbs an upward and slightly outward growth, but not spreading till they are out of the reach of the horse. Trees thus pruned are stronger, and able to carry more fruit than unpruned trees, as the weight of the fruit is borne directly on the main branches, the strain being nearly vertical, and with improved implements the ground can be cultivated by horse labour right up to the trunk of the tree without any danger of injuring the branches of the tree.

When the branches of the tree are allowed to spread too much, the weight of the fruit tends to break off the limbs or split the tree, but this is by no means all the damage, as the head of the tree is opened up and exposed to the direct rays of the sun, which scald and blister the unprotected bark, and this, in many cases, is the direct cause of many trees dying from what is commonly known as "Fire-blight."

Another most important consideration in looking after an orchard —in fact, I may say, the most important consideration of any—is to keep the orchard free from the ravages of insect and fungus pests as far as it is possible to do so.

Fruit-growers have to thank science for the knowledge of how to deal successfully with the many diseases that attack fruit and fruit trees, and, if for no other reason than this, science has proved its great value to them. Every orchardist owes a debt of gratitude to those scientists who have devoted years of careful study to determining the habits and life histories of our insect friends and foes, so that we may know which to preserve and which to destroy; and, in the case of destructive insects, that we may know when and how they may be most easily kept in check, as without having a thorough knowledge of the habits and life histories of the insects causing the damage it is impossible to suggest remedial measures.

It is not only in the case of injurious insects that science has proved of such value to orchardists, but the various microscopic fungi that cause such an immense amount of damage to the fruit industry have been made an especial study of by vegetable pathologists, and the results of their investigations have been even more marked than those of the entomologists, as diseases of which comparatively little was known a few years since, and which were generally looked upon as incurable, are now thoroughly understood and easily prevented by the application of the right remedies at the right time.

Every orchardist should make himself thoroughly acquainted with the appearance of every disease that the fruit or fruit trees he is growing are liable to, so that he may be able to detect the presence of disease as soon as it makes its appearance. This is of especial importance in the case of fungus diseases, as these diseases, if taken in hand in time, can be usually easily kept in check, but if neglected they spread so rapidly, and obtain such a thorough hold of the orchard, that it requires very careful treatment to bring the trees round to a healthy condition. Never consider any blemish of the fruit or tree, no matter how insignificant it may be, as of no consequence. It may be of no consequence, but it may be the first indication of a disease that, unless it is stamped out at once, will overrun the orchard. Therefore treat all blemishes as diseases till you have proved them to be harmless.

The various diseases of fruit and fruit trees are most economically and efficaciously treated by means of spraying, the remedies used being distributed over the trees affected with considerable force so as to reach every part of the tree, and in as fine a state as possible. The object of spraying is not to drench the tree, but to distribute the material used evenly and finely, as this is found to be far more efficacious than flooding one part of the tree and missing another, as to be successful every part of the tree must be reached.

In spraying for microscopic fungi it is impossible to get the spray too fine or too well distributed, as the spores of the fungi are on every portion of the tree, so that to be successful the spraying must be thoroughly done. The time to spray varies with the disease; but in the case of the fungus diseases of deciduous fruit trees the best results are obtained by spraying (first) when the buds are swelling in spring, and (second) when the fruit is setting, the subsequent sprayings, though of value, being not nearly of so much importance as the two mentioned. Fungus diseases attacking ripe or ripening fruit are best prevented by spraying the trees liable to attack as soon as the first signs of ripening take place, as the spores that would cause the disease are thereby destroyed. In the treatment of insect pests the remedies will depend on the habits of the insects to be destroyed. Thus all insects that live by eating their food are very easily destroyed by poisoning the food on which they are feeding with a preparation of arsenic, such as Paris green or London purple, whereas insects living by suction, such as aphides and scales, can only be destroyed by spraying them with a material that kills them on touching them. Spraying is now an absolute necessity in all orchards, and no progressive orchardist can afford to neglect it, as a small expenditure of labour and spraying materials will often be the means of saving a crop which would be otherwise lost.

There is one other question of great importance in the management of an orchard to which I will briefly refer, and that is the question of manuring. Here, again, science comes to the assistance of the fruit-grower by showing him in the first place the amount of available plant food contained in the soil of his orchard; and also, if deficient in any plant food, how the deficiency may be most advantageously and economically supplied in the form of manure. Science also shows us the amount of plant food removed from the soil by the different varieties of fruit trees, and the best manures to apply to the soil to make good the loss. It also shows us when the manures should be applied so as to produce the best results, and the best methods of applying them. In order to obtain the best results from manuring, it is necessary to make a thorough study of the plant or tree's requirements, taking the nature of the soil, climate, and rainfall into consideration. Plants, like animals, require their food regularly, not a surfeit to-day and no more for a year or longer; a regular and constant supply of the essential elements of plant food will always produce the best results. Manures may be roughly divided into two classes—those readily soluble and at once available for plant food, and those only slowly available after they have been for some time in the soil. Soluble manures should only be given during or slightly prior to a period of active plant growth, as, if not used by the tree, they are often, especially in the case of sandy soils, leached away, and so lost to the plant; but slowly soluble manures are best applied whilst the trees are dormant, so that they can be available when the period of active growth takes place. Extremely soluble manures should never be used during a dry time, unless irrigation is available, as they are more likely to do harm than good, as, if they come into direct contact with the roots, they have a burning effect in dry weather. Therefore, those manures are usually of less value in a dry climate or comparatively dry climate than where a regular rainfall can be depended upon. In using soluble manures it is not advisable to give too large dressings; smaller amounts more frequently applied will be found to give much better results.

HOW TO UTILISE AND MARKET FRUIT.

Having now shown how to plant, what to plant, and how to look after an orchard when planted, I now come to the important question of what to do with our fruit when grown, so that it will produce the best results. In order to do this I will start with the marketing of fresh fruit, and will try and show how the present method of marketing fruit can be greatly improved. It does not take an expert to see that the manner in which fruit-growers get up their produce for market is capable of being greatly improved upon, as the condition in which a large quantity of our fruit is sent to market, and the manner in which it is sent, is a disgrace to Australia.

In many cases not the slightest attempt is made to pack the fruit; and even where a certain amount of packing is done, the grading of the fruit is often very indifferent, the case having a layer or two of fine fruit on the top and rubbish in the bottom. In some instances, however, big, small, ripe, over-ripe, under-ripe, clean, and diseased fruit are all mixed together, the case well shaken to settle the fruit, and the lid then fastened down, and, in addition, the case, to say the least, is usually a very unattractive and often very dirty one; and still the fruit-grower wonders that he gets a bad price for his produce, blames everyone except himself, says that fruit-growing is done, and there is no longer any money in it.

In order for fruit to sell well it must always be shown to the greatest advantage, and this can only be done by careful picking, handling, grading, and packing, and the use of clean, neat cases.

Handle the fruit carefully; a bruised fruit is a spoilt fruit, and will spoil the sale of a case. Grade evenly, and never pack big and small fruits in the same case. Pack honestly; let the top of the case be no better than the bottom, but let the fruit be of an even quality throughout. Pack firmly, and discard all blemished or diseased fruit; they only spoil the sale of the good. If the fruit is of extra quality, or has to be sent a considerable distance to market, or is intended for export, always wrap it; a tough, soft paper being the best to use—Japanese papers, made from bamboo fibre, being the best that I know.

Many growers will no doubt say that it will not pay to go to all this expense, but I can assure them that it will pay, and pay well, as fruit properly graded and honestly packed will meet a ready sale in any market. In order to bear out this statement I may say that it is the experience of the great fruit-packing firms in California that the better you get your fruit up for sale, and the more attractive it is, the better it will sell. The large orange-packing houses of Riverside, California, consider that it costs 2s. to put up a case of oranges properly. This price includes the cost of cutting, grading, wrapping, and packing, as well as that of the case and the lithos on the case; and they find that it pays them much better to pack in this manner than to put the fruit on the market in a less attractive form, as the extra price realised more than compensates for the extra expense of packing, and in addition the fruit is more readily sold. What applies in California applies with equal force here, as there is never any difficulty in disposing of attractively got up fruit in our own markets; and in the case of exporting any fruit to the English, Canadian, or other markets it is of the first importance, as unless the fruit is of first-class quality, evenly graded, and well packed in neat and attractive cases it is no use trying to build up an export trade. The English trade especially demands a first-class article, for which they pay a good price for a practically unlimited quantity, but second-rate and inferior fruit they do not want at all.

In addition to disposing of our fruit fresh, there are several methods by which it may be profitably utilised that are at present very much neglected, the principal of which are canning, drying or evaporating, and the manufacture of fruit pulp—jam or jelly.

In order to dispose of our fruit to the best advantage, I am strongly in favour of co-operation amongst fruit-growers. I advocate the establishment of centrally located packing, curing, canning, and drying establishments, where the fruit will be properly graded and put to the use that it is best suited for; thus fruit that is best adapted for the local fruit trade will be consumed fresh, that best adapted for export will be exported, that suitable for canning or drying will be canned or dried, and that suitable for pulp jam or jelly will be so utilised.

Such establishments should be adapted to the requirements of the district where they are erected, and should be worked, as far as possible, on co-operative lines. They will require to be run by thoroughly competent men, who must be experts in the business, and who will put up the fruit in the best possible manner. It is of the greatest importance that the quality of the output should be of the highest grade, and that this standard of excellence be maintained, as unless this is done the establishment will be a failure. Such establishments can handle the fruit cheaper, better, and much more expeditiously than private growers, and they have the advantage of being able to put up the fruit, whether fresh, dried, canned, or otherwise, of a uniform standard quality, and to maintain this standard—a matter of the greatest importance when selling the produce.

Every fruit-grower should put up all the fruit he requires for home consumption, as this is easily and inexpensively done, but I do not advise the average fruit-grower to go in for canning or jam-making on an extensive scale, as I feel sure the result will, in many cases, be very far from satisfactory; rather join together and get a really good man, who thoroughly understands the business, and who can turn out a first-class article. In conclusion, I may say that the secret of successful fruit-growing is thoroughness; nothing will pay to do ill that will not pay very much better for doing properly. Choose suitable soil; prepare the land properly; plant your trees well; plant nothing unless it will grow to perfection, and only plant few varieties. Look after your orchard thoroughly; cultivate it well; prune it well; thin heavy crops, and keep down all diseases, and when your orchard has come to bearing you will have good fruit, which, if carefully handled, well and honestly packed, will sell well in any market, no matter whether it is fresh, dried, canned, or otherwise. Fruit-growing conducted on these lines will pay well, but the days of growing rubbish at a profit are past.

2.—CLIMATIC INFLUENCES ON CONTAGIOUS DISEASES OF LIVE STOCK.

By P. R. GORDON, Chief Inspector of Stock, Queensland.

Thirty years continuously spent in official positions connected with the controlling of contagious diseases of live stock in Australia have afforded me extended opportunity for observing the effects of the Australian climate in modifying, and in some instances almost changing, the character of some contagious diseases common to live stock in other countries.

Owing to our strict quarantine laws our live stock have, fortunately, so far, maintained an immunity from most of the contagious diseases prevalent in older countries, and there are only two fatal diseases in live stock in these colonies that may be said to come under the ordinary designation of contagious diseases—namely, bovine pleuro-pneumonia and sheep catarrh.

Tuberculosis, although communicable under certain conditions, is not usually classed as a contagious disease. Anthrax and several others more or less prevalent in the colonies are contagious only in the sense that they contaminate the pasture and soil; while psoroptic scab, now happily eradicated, although decidedly contagious, is not of a fatal nature.

It has been my fortune—or misfortune—to have had exceptional facilities for studying both bovine pleuro-pneumonia and sheep catarrrh.

Pleuro-pneumonia, which was introduced into Victoria in 1858, made its first appearance in New South Wales in 1862 through the herd of Messrs. McLaurin, of Yarra Yarra, in the Albury district; and under the impression that it might be stamped out by the slaughter of the infected herd, and under pressure from the cattle-owners of the colony, the whole of the cattle on the run—over 10,000—were condemned by the Government to be slaughtered and burnt, and I was employed, under the control of the chief inspector, to see that order carried into effect. The lungs and pleuræ of each animal, as it was slaughtered, were examined and reported on by me.

In respect of sheep catarrh I have also had extensive practical experience from 1857, when I lost 5,000 sheep in flocks under my charge, in Victoria, down to 1884, when the last of six serious outbreaks in Queensland, ranging over a period of sixteen years, was stamped out by the slaughter of the sheep.

The nature and symptoms of bovine pleuro-pneumonia are too well known to require description here. With the Australian type of catarrh in sheep, however, the case is different. All the outbreaks of that disease have occurred under circumstances when the services of a veterinary surgeon have not been available; and as the disease assumes here a type so much more fatal than the disease of the same name in the flocks of other countries, a short description of its symptoms will be of interest and is necessary for the purposes of this paper.

The disease, which is really catarrhal fever, first appeared in New South Wales in 1834, and for years the mortality from it was alarming. Its first appearance was in an upland district, from which it rapidly spread by contagion. The earlier symptoms do not differ from those in ordinary catarrh. It runs its course in from twelve to thirty-six hours, and in the last stage the nasal discharge is viscid and in many instances tinged with blood. The nose is more or less swollen, and the swelling frequently extends to the whole head. The sheep breathe open-mouthed, with the head extended upwards. The breathing is accompanied by a crackling noise, which can be heard at a distance of many yards. The animal becomes perfectly blind, staggers forward and towards the direction of the right shoulder, and finally falls down and dies with few struggles. In a flock of 5,000 the deaths would average from 200 to 300 in the twenty-four hours. Few that are attacked recover, and those that do become almost completely denuded of wool.

Post-mortem appearances are a highly inflamed condition of the membrane of the nose, which is greatly thickened with a tough matter effused over it. The brain, where examined, has not been affected beyond an inflamed appearance of the sinuous passages of the skull. In some cases the pulmonary organs—the larynx, the trachea with its various ramifications—have been inflamed; but in no instance in my experience have the air-tubes been obstructed by mucus, and in this my experience differs from some descriptions that I have read. In all the Queensland outbreaks the uniform report of the inspectors and those engaged in examining and burning the carcasses has been that there is no mechanical obstruction in the air-passages. The stomachs are healthy, but in almost every instance the fæces have been in hard lumps, causing, in many instances, injury to the mucous membrane of the intestinal canal. The disease has appeared only during seasons when the grass had been withered and sapless by either winter frosts or summer droughts, and, in one instance, the exciting cause was overdosing the sheep with dry salt for the purpose of expelling worms. The only successful means of checking its virulency has been by placing the sheep on a fresh spring of grass or pasture that had recently been burnt.

The disease when once set up is highly contagious, and was only finally stamped out by the slaughter of all infected flocks, and by placing the land over which they had pastured or been travelled in quarantine for a more or less lengthened period.

From the description here given it will be apparent that the disease is but a very aggravated form of catarrhal fever, common to sheep in more rigorous climates; but I cannot learn that it has appeared, during the summer months, in any other country. The malignancy of its type in Australia can, in my opinion, only be attributable to the vicissitudes of our climate, occasioning periodical droughts, rendering the herbage innutritious and indigestible.

With pleuro-pneumonia, on the contrary, our climate exercises a benign influence. On its first introduction to Australia it was of a much more virulent type than we now know it. The losses from it in Queensland during the first outbreak, from the time it entered by our southern border in 1864 until it gradually extended to our northern shores, were little short of ruinous. Fully 15 per cent. of the cattle then in the colony were carried off by it, and in many instances the mortality in travelling cattle reached 50 per cent.

At the present time the actual deaths from the disease, when the cattle are left undisturbed on their runs, rarely exceed from 1 to 2 per cent., and this in face of the fact that an examination of the lungs and pleuræ in our slaughter-yards shows that a very much larger percentage had been affected but had recovered. From these facts I think it may fairly be assumed that a time will come when the disease will become of so mild a nature in Australia that few, if any, deaths will occur from it.

It is well known that the dry atmosphere of our Western districts is inimical to diseases of a pulmonary nature, and this is strongly corroborated in the case of pleuro-pneumonia and tuberculosis in cattle.

The percentage of those cases in cattle from the West, as evidenced in the Brisbane slaughter-yards, is exceedingly small as compared with coast cattle. On the other hand, some of our most virulent attacks of sheep catarrh have been in districts far removed from coastal influence. Pleuro-pneumonia and tuberculosis make greatest headway in a humid atmosphere. Catarrh, on the contrary, disappears under a similar influence.

It is worthy of mention here that pleuro-pneumonia is more prevalent on basaltic soils, such as Darling Downs and Peak Downs, than on the Upper and Lower Cretaceous formations of the West.

By what special agency this is brought about I am not prepared to say, but would imagine that, the Cretaceous formations being of a more saliferous character, the herbage would necessarily partake of the same nature, and therefore be more invigorating.

I think I am justified in deducing from the facts I have stated that in diseases of a pulmonary nature, such as pleuro-pneumonia, the effect of our climate is to diminish their intensity, while with those of a broncho-febrile nature, such as sheep catarrh, it has an opposite tendency.

While arriving at these conclusions, I do not ignore the fact that the mitigation of pleuro-pneumonia may, to some extent, have been due to hereditary immunity. Indeed, I have had practical evidence of such a contention. In our operations for the artificial production of inoculation lymph, carried on during the past five years, it has been our frequent experience that calves, obtained from a herd in which pleuro-pneumonia had existed within a period of two or three years previously, are in many instances immune to the disease by inoculation, and I have it on the authority of many cattle-owners that they have had similar experience.

Nor can we overlook the fact that some diseases lose much of their virulence by acclimatisation, so to speak. This is the case with rinderpest. In its native habitat, the steppes of Russia, although constantly present, the mortality from that disease is inconsiderable, whereas, when introduced into low countries and to Great Britain, its ravages have amounted to almost total annihilation of the infected herds. So with Australian catarrh. In the upland districts, in which it lingered for many years, notably the Monaro district of New South Wales and the Upper Burnett district of this colony, the annual losses from it were small; but when communicated by sheep from those districts, and set up in fresh localities, its ravages have been very great.

Those who have had practical experience in the breeding of stock are aware of the powerful influence exercised by the Australian climate in modifying the types of sheep and cattle. Is it not therefore reasonable to assume that a similar influence will be exercised in the modification of diseases to which the same description of stock is liable?

3.—POSSIBILITIES OF COOLING, CHILLING, AND FREEZING AS AFFECTING AUSTRALIAN AGRICULTURE.

By ANGUS MACKAY, F.C.S., Instructor in Agriculture, Technical College, New South Wales.

The term *Agriculture*, as used in this paper, is intended to apply in its fullest sense, as embracing the various branches of live stock, general farming, and garden cultivation, including the products thereof.

The control which is being gradually won over temperature as being beneficial or destructive, and the effects upon agricultural products—both vegetable and animal—which follow when cooled, chilled, or frozen, are opening immense fields of possibilities for Australia. By the aid of reduced temperature products which were formerly confined to the cities and towns, and their immediate surroundings, are already finding more extended outlets in districts where fresh fruit, as an instance, was scarcely known. Products such as meat, milk, butter, &c., are also being supplied to the towns in much greater quantity, and of decidedly better quality, by the aid of cooling conveniences, of cold storage accommodation, cold chambers on the railways and on shipboard, the uses of which are extending rapidly.

Then, looking further afield, we see many of the products of Australia already placed in the great markets of Europe, and in such condition as has, even in the face of visible defects, won for them a fair share of appreciation from consumers who are used to having the very best products of the world in their markets.

My purpose in this paper is to examine into the possibilities of extending the trade so favourably opened, not only for the products which have been tested, but for many others that come within the agricultural capabilities of the country. What has been attempted with success affords confidence that we are on the right track; what may be possible offers encouragements of no ordinary kind to the business man, and also to scientists, always on the alert to aid in spreading the benefits of industrial efforts towards the production of improved and extended food supplies.

In view of the subject thus opened up, the kindred products of meat, fruits, and vegetables may be grouped as being capable of similar treatment for transportation and marketing purposes. There is, in the sense of the agriculturist, no limit to the extent to which any or all of such products might be increased. It is a simple matter of skilled agriculture, of suitable soil, suitably fed and treated, so as to yield all that might be required. The means of distributing our products, of marketing them profitably, offer greater difficulties. They presented difficulties which seemed veritable barriers in the days prior to chilling and freezing. For years the main hope of thinking men, who looked to advanced agriculture as the true foundation of the country, was in such an increase of population as would enlarge the demands for more extensive agricultural operations. There was the serious drawback, however, in the face of increased population, that supplies of fresh vegetables and meat would have to be confined very closely to the localities where they were produced. That difficulty is being cleared away. There is now the possibility that millions of people may occupy the seaboard sections of Australia, and that with the aid of irrigation immense stretches of the less heavily watered interior may become the centres of large populations with ample supplies of food materials of the best quality at their command.

Such, in brief, are some of the better prospects for Australian agriculture made possible through the agency of chilling and freezing.

The appliances available are also being simplified, and the cost reduced to an extent which warrants the belief that ere long every branch of business in need of the help which colder temperature supplies will have this aid at command.

The agencies employed for the production of cold are ammonia, carbonic acid, air, and ether. Other agencies are used, but those mentioned are most in favour for practical purposes, and generally in the order named. So marked have been the improvements made in the machinery used for producing cold, and the skilled mechanics in charge have such control of the delicate materials upon which the machines operate, and so well are the power and peculiarities of such substances as ammonia, carbonic acid, &c., understood, that accidents to either the person or machine are few, and seldom serious.

When we consider that a very large portion of the work of making cold is carried on at sea during long voyages through the most trying parts of the tropics, there is every reason for confidence that absolute control over temperature—for the production of cold to chill or freeze as may be needed, and for maintaining the temperature at any point which has the effect desired upon the cargo is only a question of time, and that thawing can be carried out in such manner as to restore the meat, fish, or fruit to its normal condition before chilling.

My own experiments and tests, as showing the effects of cold upon substances which are already among our exports, may be of interest and use at this stage.

The water contents of all the substances are most immediately acted on by cold. Assuming that water is at its most dense or solid form at a temperature of 39° F., when lowered beyond 39° water increases in bulk, and we generate snow and ice, both of which are more bulky and lighter than water at 39°. Then, as we raise the temperature, the bulk of water again increases until it vaporises into steam.

All this seems simple enough. The facts and conditions are easily understood, and conclusions appear feasible that the watery contents of meat, fruit, fish, and other substances can be so controlled by chilling from 45° to 32°, or by freezing below 32°, that substances can be preserved and carried in such a semi-solid form, and below the range at which bacterial life is active, and that the preserving of the substances will be absolute and certain when so treated. But experience has not given such satisfactory results. While as a whole the business of transporting in the chilled-frozen state has been carried on with such creditable results as are nothing short of wonderful, disappointments and losses have occurred, in the face of all the care and skill exercised. It may be safe for me to add that no two cargoes have been carried with identical results, although the same care was taken throughout; and much the same results have followed experiments made with fruits, meat, &c., both in chilling or freezing temperatures. It seems to me, therefore, that at this stage those who have opportunity to make tests can do efficient practical service for the export aspect of Australian agriculture. I offer here some of the observations made with substances affected by lowering the temperature to 32°.

Fish radiates its heat more rapidly than meat; meat more rapidly than fruit. Fruits contract by freezing, and different fruits are affected differently. Thus well-grown, matured apples contract, but thaw out again without injury to the quality of the fruit. Grapes rupture at 32°, and seem to be injured by temperature lower than 45°. Oranges seem less affected than any other fruit by freezing; ripe pineapples shrink, and are injured, while the unripe fruit is not so affected; ripe bananas are injured, while the unripe seem to be helped towards ripening.

Sugar-cane is not injured by freezing when cut and maintained in the frozen state, but thawing sets up rapid fermentation. Cabbage becomes tender by freezing, and is generally improved. Passion-fruit shrinks and thaws out uninjured. Potatoes and turnips shrink and are injured by freezing, while carrots become sweeter by freezing. Eggs expand, and numbers burst at 32°. Maize is uninjured at 32°, and weevils are killed. The foregoing are results of observations that may be helpful in the study of cause and effect in treating material for shipment. Much has yet to be discovered, as it seems to me, concerning the effects of cooling, chilling, and freezing upon the laws of crystallisation, condensation, and evaporation. As an instance, I find marked differences in fruits containing malic, tartaric, and citric acids. Possibly other substances, such as meat, fowl, fish, &c., may be affected by their leading chemical contents. I think it will be found that substances having the smallest natural proportions of water in combination will be affected least in the changes inherent to cooling and thawing. The latter process develops its most serious effects upon both meat and fruit that is soft in comparison with what is more mature and solid. In this respect it is found that food tells upon animal substances, and even upon eggs. Soft, watery fruits carry badly. Instances may be cited of fish frozen in such masses that they could not be separated without injury on thawing; also tongues, kidneys, &c., of sheep and cattle when frozen in masses. Thus matter containing heavy proportions of water gives best results when chilled or frozen singly.

Brief though this outline is, immense possibilities seem to me to be associated with it, as results show. That facilities for cooling, chilling, and freezing will be amongst the greatest helps for extending our agriculture seems very evident. By this means grain may be stored in absolute safety as against the serious losses now inflicted by insects.

Pigs may be killed and converted into sides and hams at any time of the year, when the meat can be cooled down to 40° before curing.

Poultry, rabbits, hares, &c., may be treated in somewhat similar manner.

Cream can be cooled and carried to the central factories where uniformity in butter-making for export is possible.

The whole subject is replete with such possibilities as may call out the best energies of the many able minds interested in the proceedings of this congress, and may tend towards the best interests of the country.

4.—OUR DEFENCES AGAINST LOW PRICES OF FARM PRODUCTS.

By E. M. SHELTON, M.Sc.

The extraordinary recent depreciation in the values of farm products must be accounted one of the most striking facts of modern history. The movement of values has not been a uniform one; the flow has had its ebbs and side-currents, but its general course during the last decade has been unmistakably towards lower levels. The result of this steady falling away of crop values is seen in the obliteration of the profits of farmers practising under old-time conditions, and the reduction of their purchasing power until the solvency of a considerable class of the community is threatened. Very much of the most important recent legislation of the Australian colonies is but an endeavour to meet with statutory enactments the pressing difficulties forced upon the community by low prices. Our laws providing bonuses for the exportation of products, the various Acts looking tot he establishment of dairy factories, meatworks, and sugar-mills, the whole protective system, much of our recent land legislation, and the proposed land tax, with many other measures, are but the incidents of this pronounced drop in the value of soil products. Whether this legislation is likely to accomplish its object needs not to be discussed in this paper. The considerable number of persons resident in each of the colonies, whose political faith in one disguise or another embraces the idea that prosperity may be enacted, will doubtless find in the results so far obtained ample justification of these extraordinary measures.

It is instructive to note that the existing low prices due to glutted markets and the over-production, which is here assumed without debate, is due in no case to good farming, but always to bad. Rotation of crops, chemical manuring, underdraining, and those other practices commonly grouped under the heading "scientific agriculture" have had no part in the recent superfluous production, and consequent demoralisation of values, of wheat, meat, and wool. It is the abundant crops growing out of the scourging system in vogue upon the plains of Argentina, the prairies of Dakotah, in India, Southern Russia, and South Australia that have brought the price of wheat to the lowest point known to the present generation. At least as much may be said of the modern production of meat, wool, and cotton. At the present time the scientific farming of Great Britain and the Eastern and Middle States of America may be said, speaking figuratively, to be engaged in a life-and-death struggle with a system which utterly ignores science, with the chances, for the present at least, largely in favour of the unscientific system. The use of machinery in modern farming is undoubtedly the most important contribution of science to the existing surfeit of farm supplies, but machinery, it should be added, is quite as much an aid to bad farming as to good.

A discussion of the causes and probable continuance of the prevailing depression in the prices of farm products has no place in the scheme of this paper. I take it for granted, in a general way, that the tendencies, stronger now than at any previous time, are towards lower prices, and that the downward movement of market values will be continued until prices, at the great sources of supply, are reached which are insufficient to cover the cost of production with reasonable profit to the producer added.

Man's inherent dislike of labour, where the incitement of gain is wanting, and the numerous channels in which human energies may, under modern conditions, be profitably directed, should be counted on to ultimately check the over-production which brings loss to the producer. My own impression is that the great market supplies of grain, meat, and cotton have, at least until very lately, taking things by and large, given a profit to the grower, and that wool has not. Bad farming, in common with vicious methods in general, cannot be a permanent condition. The best soils sooner or later refuse to yield a profitable return to scourging methods, and the richest of natural pastures are ultimately "trod out" in a system which recognises no operation but that of harvesting. If we were certain that no undiscovered Argentinas or Dakotahs were in store for us, we might safely assume the temporary character of the existing low prices. Natural law is self-enforcing, and here, as elsewhere, is certain ultimately to prevail despite the trumpery efforts of human legislation. In the great industrial strife reflected in the world's markets, the most resourceful people will win. The battle here is always to the strong, and the race to the swift. What the chances of Queensland producers are in this "great impending conflict," for Queensland can hardly be said to have yet entered it, is the practical question proposed for discussion in this paper. A sufficient explanation of its scope is given when I say that the plan is to touch not so much upon the natural as the artificial and remediable conditions that surround production in Queensland.

The natural resources of the colony, as related to soil products, can with difficulty be overstated. Unmeasured tracts of fertile soil, inland and coastwise, an equable climate that knows no winter in the European or American sense of the word, and products that vary in all degrees between those normal to the temperate and tropical regions of the earth are the prominent features of this natural wealth. There is nothing more impressive in the agriculture of Queensland than the variety of field and orchard crops that flourish in particular localities. I have myself counted twenty-six different fruits, embracing apples, plums, bananas, and mangoes, growing and apparently thriving in a single fruit garden. In this strife of industrial competition the Queensland cultivator has small cause for complaint of lack of opportunity, either in suiting his own taste or the requirements of the market. How are these resources utilised, and what are the reforms in practice, if any, needed to lift our cultivators to the level of their opportunities?

The history of modern industrial enterprise is a record of success founded on temporary disaster. In the commercial world, no less than in the physical, strength and beauty spring from pain and decay. Death, in the realm of business as in animal existence, is as much a part of the scheme of nature as life. Great commercial companies arise from the ashes of dead ventures and fatten where they have failed. Old ships rot in every port that newer and better ones may do the carrying trade of the world. Every modern farmstead has its "scrap-heap" of obsolete stock, tools, and ideas that have been forced into retirement by modern improvements. It is the effort to compete in business with out-of-date methods and machinery, or with property held to a false standard of values, and the loss sustained in readjusting these to modern requirements, that give us much of the "hard times" and "depression" so generally complained of. The pastoral industry supplies thousands of illustrations of the utter failure of present attempts to earn dividends upon capital values based upon the current prices of station supplies and products a few years ago. A squatter of large means commenced business ten years ago upon an extensive freehold property in Central Queensland. In the outset he found it necessary to make certain expensive improvements; buildings had to to be erected and dams made, and the incursions of marsupials forced him to the heavy expense of netting the estate. This wire-netting, bought in London, cost at the time £70 per mile; it might to-day be replaced at about £20 per mile. So long as the seasons continued favourable and wool fetched 1s. per lb. all went well; but two bad years, followed by a heavy drop in the price of wool, completed the ruin of the squatter. The present owners are at this time engaged in what must seem to them a desperate effort to earn 7 per cent. upon this over-valued run, with its fencing costing £120 per mile, and other improvements on a similar scale of values. Reduce the valuation of this estate by "writing off" to that of similar properties held by our competitors at the Cape or on the River Plate, and the Queensland property will pay handsomely even at the present prices of wool and meat. Our natural defences here are beyond all question secure; the only doubt relates to the artificial lumber which encumbers them.

The business of cane cultivation, and the manufacture of sugar in Queensland, is a modern instance of the upbuilding of a great and flourishing industry after complete wreck and collapse. Sugar production is, perhaps, to-day the most popular branch of Australasian agriculture. Although the market value of sugar is the lowest known in history, its production is confessedly profitable alike to the grower and manufacturer. It is hard to believe that five years ago the whole Queensland coast as far north as Cooktown was dotted with insolvent sugar estates. It is difficult to conceive of a more generally discredited calling than was sugar-growing at that time. The attempt had been made to grow cane upon greatly over-valued lands, to manufacture sugar with out-of-date machinery, and to combine in one interest cane-growing and sugar-making. The result was, with few exceptions, disastrous. It required only the threatened loss of island labour to bring the industry to a state verging upon collapse. Mills were offered at the buyer's price, and the best sugar lands changed owners at figures that scarcely matched the cost of the improvements upon them. Out of all this wreck and ruin the present successful sugar industry has grown. Modern machinery has made the profits of manufacture so large that the mill-owner has been enabled to pay the cane-grower prices far beyond those known in the old times when the trail of the boom was over it all. Here again Queensland's unfettered resources intelligently handled have proved an ample defence against the encroachments of low prices. Any thing or system that tends to prevent this natural process, by which an old and vulnerable position is abandoned for a newer and stronger one, retards progress, and thus militates against the best interests of the community. One of the strongest arguments that can be urged against State ownership of railways is that the interest charges upon their cost must be met either from the earnings of the road or by a tax upon the entire community. Whatever may be the value of the services of the roads, the semi-annual dividends must be forthcoming. There are no shareholders, as in the case of privately owned railways, to whose convenient shoulders the burden of loss, due to excessive competition, bad management, or extravagant first cost, may be shifted. This fact, to my mind, explains in good part the persistence of the depression which has so long overshadowed Australasia. In every civilised country railways are the key to the industrial situation, for, beyond their own intrinsic importance, the value of every species of property depends upon them.

Our methods of cultivation, and the subsequent handling of crops, burden the producer in the race for market position. Illustrations of this may be found in every department of colonial agriculture, sugar-growing alone excepted. I can here only instance a common colonial method of handling the maize crop. The ground is first ploughed and harrowed in the usual way; then it is marked off, one row at a time, by the plough again. The land is then ready to receive the seed. This is applied by hand, the planter dribbling the seed maize along the row at a slow walk. The result of this inaccurate seeding is usually an imperfect stand of the young crop. The plants may be too thin on the ground, in which case replanting is resorted to; or the stand may be too thick, necessitating the removal, by hand, of the superfluous plants. Then the lateral shoots growing from each maize plant are removed—a wholly unnecessary task—and the usual cultivation of the growing crop follows. Until quite recently the practice has been to mound the earth about each plant with a hoe (hilling), but this practice our farmers happily have outgrown. In due course, after the maturity of the crop, the ears with containing husk are broken from the parent stalk and hauled to a convenient shed, where they are at a later period husked. Then follow shelling and cleaning, often with a small hand machine, having a capacity for 15 bushels of grain per hour, which done, the grain is bagged for delivery at the nearest railway station. This last operation brings to a conclusion the work of the farmer in connection with this crop of maize. It is not too much to say that a large part of this work has been unnecessary and wasteful, having advantaged neither the crop of maize to which it was applied, nor the condition of the soil in respect to succeeding crops. To go into details with this criticism, the method of marking off the land, of planting, of cultivating and harvesting the crop are unnecessarily wasteful in labour and inefficient; the suckering and hilling, when done, are wholly superfluous, while the necessity for expensive bagging would not exist with proper market and transportation facilities. All this will be seen in a glance at the process by which our competitors, the Americans, grow this same maize crop. In the States two general plans are followed with the corn crop; the land is ploughed as usual, as a preliminary to planting, or the crop is "listed." The lister, I may add, is a plough with double mould-board, and is ordinarily equipped with planter and covering apparatus. It makes a furrow for each row of maize. Under the listing system a man and team of three horses plough, mark the ground, plant and cover the seed at one operation, doing about six acres per day. In the cultivation of the crop two rows are taken in each passage of the cultivator across the field. The hand hoe is rarely used, except where the ground is very foul. The husking is a single operation. The ear is roughly freed from the enveloping husk—a good workman doing 60 bushels or more per day—and thrown directly into the wagon, which carries the crop to its destination, which may be a "crib" for storage in the farm, or an elevator where the ears are shelled, and the grain run into bins, suitably graded, whence it is spouted directly into railway trucks.

A comparison of this simple and direct way of winning a crop with the cumbersome and complex methods in vogue in Queensland serves to show the artificial burdens under which agriculture labours. When the colonial farmer's crop has been made, and is ready for delivery at the railway, the odds against him are still very heavy. He must sack all of his crop, at a cost of 5½d. the 4 bushels; he must load the truck with his own hands, and it is to be presumed that in the end he pays for unloading and for transferring from the railway station to the produce merchant's quarters in Brisbane. Again, compare the colonial producer with his American competitor in respect to facilities for marketing. The Yankee farmer drives to the elevator with his load of maize, where the weighbridge promptly gives him the weight of his load. Then, at the touch of a lever, the rear wheels of the wagon drop a couple of feet, and in a second the load is shot into a hopper at the side of the weighbridge, and from thence is carried to the elevator where it is shelled (if in the ear), cleaned, and graded, and delivered to the proper bin, from which again it is spouted directly to the railway truck. When the truck reaches its destination, a steam shovel empties it into a hopper, from which it is lifted into the elevator of some trade centre. The owner of the grain may now receive from the elevator a receipt for so much grain of a certain standard of quality or grade. This receipt will now do duty in the commercial world for the grain which it represents. It may be held, sold, or transferred at the pleasure of the owner, and it is negotiable at the bank precisely as is a bill-of-lading or warehouse receipt.

Much of the foregoing criticism of existing farm practices applies to other crops than maize, but in marketing existing methods burden nearly all branches of production alike. It is cruel to the farmer that crops, at times almost valueless, like hay, potatoes, and maize must be bagged as a preliminary to shipment. Surely the transportation system of the colony admits of modification to the extent of permitting bulk shipments of grain and produce, even though elevators are not forthcoming. Here, at least, is one of the most vulnerable of our industrial outworks! With transportation rates upon the basis of values of ten years ago, without elevators or cold storage conveniences, with the excessive cartage rates, warehouse charges, and in many cases lighterage charges, growing out of our failure to connect the internal transportation system of the country with the good harbours which stud the coast, it is not surprising that the colonial producer, sorely pressed on every side by competitors free from these artificial burdens, and scarcely knowing which way to turn, ends by a pathetic appeal for aid to the Government of his country.

I have already referred to the American elevator system as one of the growing needs of the colony. Our rivals for supremacy in the European markets have not been slow in utilising these modern conveniences for handling produce. The introduction of the system of grain elevators in India is the subject of two important Blue Books recently issued by the British Government. As far back as 1889 Lord Cross, the then Secretary of State for India, urged upon the Indian Government the great importance of this matter, intimating that the Government might properly assist the project thus proposed. In Russia the elevator system has become firmly established on the railway lines, centring at Odessa and Novo Rossiesk. Immense grain warehouses, having a capacity for 65,000 tons of grain, have there been built by a single railway company. So perfect is the system by which the grain of the Caucasus is handled that, at the port of Novo Rossiesk, a cargo of 2,000 tons of wheat may be shipped in twenty-four hours. We have only to consider the artificial burdens under which production in the Australian colonies staggers to understand why depression comes and so persistently stays with us, while good times seem always to be contingent upon the successful negotiation of a Government loan in the London market.

Finally, this inquiry is directed to those influences which tend to correct the existing defects of our industrial system. Naturally our hopes for improvement are centred about the youth of the colony, with whom, in a general sense, the future of the country rests. Wisely, as most of us believe, the nation has undertaken the great work of educating our children, presumably because it is for the good of the State that it should do so. Does the existing educational system tend to strengthen our youth for the struggle for existence that will inevitably overtake them? By its fruits it must be judged. With those gentlemen who plead so strenuously for education for its own sake, for "the development of mind rather than machinery of so much horse-power," we have no contention. Here, as in the fable of the shield, the question has its two equal sides. Few will dispute the dictum of Mr. Gladstone that "the man is greater than his works, and must not be bounded by them." On the other hand, in the animal economy, the stomach is of greater importance than the brain. The poet and the philosopher, equally with the labourer, must have food and the ability to eat and digest it. The question, "What shall we eat, and what shall we drink, and wherewithal shall we be clothed?" is a fundamental one; and any scheme of education that fails to take this fact into account must be defective. The bulk of our school population, whatever their mental attainments may be, will in the near future be delvers in field and mine or workers in factories. So far as the mere elements of education are concerned, the three R's are indispensable. The tools of knowledge—the ability to read, write, and compute—must be insisted on for the good of both State and individual. But beyond this our educational efforts ought to be directed towards bracing up the youth for the industrial struggle for existence that lies before them. How educational methods fail in this are briefly stated in what follows:—

(1.) The existing machinery of education utterly crushes the individualism of the pupil. The tastes or bias of the student, unless, happily for him, his predilections run with the curriculum, are too often regarded by the teacher as so many asperities which it is the principal office of the educational machine to smooth down at any cost. This, from the standpoint of industrial life, where originality and acuteness count for so much, is peculiarly unfortunate.

(2.) The most important of all the lessons of childhood—the habit of work, the disposition to work with the hands—has no place in the curricula of the schools. On the contrary, the tendencies have set powerfully in the opposite direction; holidays are multiplied inordinately, and more play, in the shape of additional immunity from work, is the recognised reward for all forms of meritorious conduct in the schools. In view of these facts, which I believe will not be questioned, the universal distaste of colonial youth of the better sort for industrial pursuits ought not to surprise us. In the meantime, and despite the hard times and the numerous unemployed, all forms of amusements—the various clubs, games, races, sweeps, and lotteries—receive wholesale patronage; and we have to-day the spectacle of the entire nation holding its breath over the outcome of a game of cricket. It is a question worthy of our thoughtful consideration whether with all of our great and unquestioned natural advantages we can maintain industrial competition with a people like the Americans, say, who do not know the meaning of the phrase "half-holiday," whose week is always six days, whose day's work is never less than ten hours, and who have only three holidays in the year, and know no national game to speak of. It has been said that the battle of Waterloo was won in the numerous cricket matches played in rural England. I venture to say that it will require something more than a knowledge of cricket and polo, or that peculiar mental vision which enables the gifted few to "pick the double," to win the industrial Waterloo that must be fought in the near future.

(3.) The ultimate destination of our school population is not the learned professions. I take it that few, even of the pupils of our grammar schools and colleges, will be doctors, lawyers, ministers, or bank clerks. These students of to-day are, for the most part, the farmers, squatters, miners, and business men of the future. Is, then, a knowledge of the humanities, so called, a mastery of the properties of the parabola or of the Greek hexameter likely, more than any other class of knowledge, to help these young people over the hard places in life? This colony has recently, it is presumed as a matter of necessity, imported men versed in certain industries—dairying, meat-preserving, tobacco-growing, and general farming—in order that our colonists may benefit by their advice and instruction. Meanwhile our high schools and colleges are busy with the work of making experts in the knowledge and methods of the ancients. The lessons they strive to inculcate concern, not the wonderful natural and exotic products of the colony, and the modern and scientific methods by which these may be made available to man, but the thoughts and languages of nations who died and were decently interred hundreds of years ago. These peoples perished thus untimely, presumably because they were unable to meet the competition of more vigorous and enterprising nations. It is not my purpose here to enter that old discussion anent the old and the new in education. It is sufficient here to point, with a note of triumph, to the results of this famous controversy, as seen in the ninety-seven agricultural colleges and experiment stations that have sprung up within twenty-five years in the United States, and the numerous similar institutions that dot the face of the European continent. We need more than Masters of Art: captains of industry—men who by education and training are capable of leading the people in the thought and action which centre in productive enterprise. To imbue the youth of the colony with this spirit of modern times, to enlist their exuberant energies in the great work of developing the abounding resources of the colony, is worth every sacrifice that it may cost individual or nation. Without the aid of young Queensland, our position in this merciless competition of modern trade will not be an enviable one.

5.—THE SCIENCE OF STOCK-BREEDING.

By C. C. MAIR.

When left without man's interference Nature culls or selects only in order to propagate animals with strong vitality, or the fittest to survive under their conditions of life, and has thus evolved and established breeds and types with strong prepotency specially adopted to their surroundings. When man takes control of the breeding of animals he selects with a view to making them more profitable for specific purposes, such as milk, meat, wool, swiftness, endurance, or fancy. There are some well-known principles which experience has established for guidance in the moulding of any type of animal a breeder may conceive as his ideal. The chief of these is heredity—like producing like. This principle of like producing like applies more to family types or ancestry than to individual parentage. Notwithstanding strong heredity there is always great variety, no two animals or blades of grass being exactly alike, and this variability gives plasticity and enables the breeder to mould a type of animals, by persistently culling off from breeding those least resembling the ideal he aims at giving form to, and breeding only from those most resembling his ideal. By continuing for generations thus persistently working for his ideal by selection and treatment, the breeder may gradually approach his conception of a perfect animal for the purpose for which he is breeding, but will not attain it, as his ideal will improve with experience, his taste gradually getting more and more critical.

In a few generations a certain amount of fixity of type and family characteristics with some prepotency will be established, if mating together those most resembling the ideal, and consequently like each other, is persistently adhered to. Fixity of type and prepotency cannot be established while crossing or corrective measures with dissimilar improved and prepotent breeds are resorted to. Fixity of type and prepotency in improved breeds is really what constitutes purity of blood, as it is a contradiction of terms to say that any improved breed is literally the original unimproved native type, the intention and purpose of improving being to eliminate all undesirable properties of the original breed, and to cultivate, foster, and fix those of economic value either for profit or pleasure.

When fixity of type or prepotency to reproduce the cultivated characteristics is broken down by crossing or mixing of types with highly fixed dissimilar improved characteristics, the unimproved characteristics of the original native breed speedily reassert themselves, and breeds so treated soon revert to that most prepotent of all types for which Nature has been culling for numberless generations. Crossing improved breeds is the great cause of atavism or throwing back to the unimproved original type.

In some cases the progeny of a cross in highly improved breeds is more valuable than either of the improved types of parent for certain economic purposes, such as butchers' meat; but for stud purposes or propagating an improved type they are worthless, the power of like producing like of either type being destroyed, and it would take a long process of grading-up to a fixed ideal to re-establish this power. Crossing highly improved breeds produces changes the effects of which no one can foretell.

In propagating animals for the purpose of improving their species in any particular line, very close culling is necessary in order to prevent constitutional weakness being established. Through the extra care in feeding and treatment generally of animals bred with valuable specialties, constitutional weakness cannot be so readily detected as when animals are left more to the trying vicissitudes of Nature, and stud animals being of high market value are often, in place of being culled and not allowed to breed, sold for the ostensible purpose of improving their species, but really to propagate constitutional weakness and consequent diseases. In animals bred for a specialty there is danger of abnormal developments in that special direction, to the neglect and injury of vital organs. The fitly building up or proportioning of the animal system as a whole must not be neglected if we would maintain constitutional vigour.

We sometimes hear it asked, What breeds are best? It is impossible to give a direct answer to this, so much depending on conditions of climate, soil, markets, &c. Each and all our recognised improved breeds have particular characteristics suitable for certain environments and economic purposes. On taking into consideration the many different breeds and varieties of domestic animals in the old world, where they have been acclimatised for numberless generations, we find each specially adapted to the district in which it has developed—the small wiry blackfaced sheep to the Scotch and Welsh mountains, the slow heavy Lincoln to the fens, the Highland pony to the hills, the heavy Clydesdale to the straths, and so on. If anyone in breeding makes up his mind to cultivate a type of animal that is not suited to the surroundings, he must be at great expense time after time in getting fresh improved blood to keep them near the standard he wishes, because he is not working in harmony with Nature's laws. In older densely peopled countries direct natural influences of soil and climate can be and are materially modified by hand-feeding, housing, and the consequent close attention by man; so that there is more necessity for taking local influences on breeds into consideration in our vast territories, where the means of modifying natural conditions are as yet limited, and where, as Mr. Wragge, our meteorologist, says, "Nearly every variety of climate except arctic is experienced." By studying closely the original homes of the various old-world breeds we may form some idea of what breeds are most likely to suit particular localities in these colonies; but it is questionable if these breeds can be profitably cultivated if we persistently adhere to the old notions of what are the correct and necessary characteristics of particular breeds, and not encourage modifications suitable to local conditions and the consumers' demands. In many districts, particularly in regard to sheep, the breeder will with advantage study the style of animal and wool that the country tends to produce, and cultivate and improve on the lines so indicated, thus saving the expense of time after time purchasing improved blood in the attempt to keep them to a type not suitable to their surroundings.

In choosing highly bred animals with recorded pedigree for the purpose of improving stock, it is more difficult to find out if the fixed characteristics and properties are truly improvements than to find out the amount of purity (fixity) or prepotency, as this can be learned from truthful pedigrees. The greater the prepotency, high breeding, or purity, the more dangerous constitutional weakness or any fault is, since prepotency is equally powerful in reproducing good and bad qualities. Males or females with long unbroken recorded pedigrees, indicating great fixity of type, may, through injudicious treatment, have become so constitutionally weak that it would be ruinous to use them to stamp their likeness on any stock. To this breeding from animals of high-class blood and great prepotency, but of low constitutional vigour, may in a measure be attributed many of the diseases and failures so prevalent. In stud stock close culling is particularly necessary in order to maintain constitutional vigour.

The chief thing to aim at in breeding being constitutional strength or symmetry, the even balancing or just proportioning of all the animal organs and faculties is all-important, so that it is doubtful if one who has not the natural gift of a true eye, with opportunities of cultivating it on good models, can be a judge or successful improver of stock. A true eye in breeding may be said to be as necessary as a true ear for music.

Fitness to survive through constitutional vigour or vitality being thus the first principle in improvement, it is necessary for their highest and most profitable development that animals never get reduced in vitality from any cause whatever, and that they never suffer from pampering or want of abundant health-giving exercise. Want of natural exercise or disuse of particular organs induces shrinkage, deformity, and decay in these organs, and if conditions continue favourable for many generations to this state, these deformities eventually become constitutional, and in highly bred or highly prepotent stock they will be much intensified by heredity. Not only are the disused organs changed, but in the attempt to maintain harmony and symmetry many other organs will be modified so as to fit in with the alteration. If from disuse an organ does not demand sustenance, the supply eventually ceases.

As we have great natural advantages in mildness of climate and richness of pasture for the production of healthy, vigorous stock, the greater number of our domestic animals are, comparatively speaking, left to take care of themselves. When they are thus without man's assistance, Nature kills off all weak or abnormal developments in culling for the survival of the fittest or those possessing constitutional strength. Man, having taken control of their breeding, has trained them out of Nature's course, and they become dependent in a great measure on his attention for their survival. So that, being again left comparatively to themselves, Nature commences culling off the abnormal developments induced by man's treatment back on the lines of the original hardy unimproved prototype. For example, in animals that have been bred specially for early maturity and enormous meat production, it is found under the forcing influence of our soil and climate that the most highly improved in this respect are soon culled off, if man does not interfere, through the female either breeding too early or, when they do reach a fit age, through being in too high condition to breed at all; consequently only the least highly improved in that specific line—those most resembling the original unimproved breed—are permitted to survive or propagate. In the same way if milking propensities are abnormally developed, it is found that after parturition, when left without man's care, from the great flow of milk the milk vessels often get inflamed and swell up so that the young one, not being able to draw it off, gets weak and probably dies, while the dam is not likely ever to rear her young on account of permanent injury to these organs. In wool production abnormal development may frequently be seen when the wool grows over the face, covering the eyes of the sheep, and causing it to be unfit to take care of itself. Many like illustrations might be given. In matters appertaining to general health, when man puts more stock on a given area than Nature would permit, she rights it herself by killing off all the weakly constitutioned and predisposed to disease, by what we choose to call diseases and pests. This is Nature's mode of readjusting the balance in order to preserve a living remnant fitted to survive some of Nature's many modes of culling. When pasture is closely stocked up by any one class of stock, sanitary arrangements must be made for keeping it fresh, clean, and untainted by disease, measures being at the same time taken for killing off and burying or otherwise finally disposing of all diseased, delicate, and unprofitable "wasters," so that they may not disseminate disease among others. On dirty, badly managed pasture the constitutional tone gets low and predisposes stock to disease. Nature puts a stop to unnatural developments and restores the constitutional balance in her own way when man is wanting in knowledge or energy to do so. Proper sanitary arrangements cannot be made in enormously large paddocks, nor so well on very large holdings as on moderately small ones.

It is the opinion of men of practical experience, who have had opportunities of judging, that the average quality of our flocks and herds generally is equal, and in some classes superior, to any in the world; and this ought to be so, considering that from the commencement of breeding in Australia there has been the power of using the most highly improved imported animals. From a national point of view what has to be considered is not the present immediate demand for certain crosses or mixtures of improved breeds, but the effects on the future of our stock of breaking down the prepotency of highly improved breeds, while not establishing or preserving types with fixed characteristics suitable to their surroundings. It would be a national benefit, were it practicable, to procure the evolution with prepotency of valuable new types adapted to our special conditions of climate and markets, but this cannot be done by breaking down highly prepotent breeds in experimental crossing. It may be done by persistently breeding in the district to an ideal in harmony with the surroundings, and consistent with the principle that like begets like, therefore mating like with like, and not with discordant dissimilar breeds. It would be absurd to look for prepotency in true mongrels, which the progeny of any such cross may be termed, as they have no power of retaining, fixing, and reproducing the improved qualities which they have inherited from their strongly prepotent and highly improved ancestors, and on account of which qualities, probably improved through the cross, they are by some selected for breeding. The progeny of a cross may be a very good animal for the purpose for which it is produced, and may show valuable characteristics of either or both breeds, but it has not the power of reproducing its own characteristics or qualities.

There is at present in these colonies a strong inclination to produce crossbred merino sheep for the home export meat trade. Under present circumstances this may be a necessary and wise course, but we must not forget that the improved English coarse-woolled breeds have been for many generations cultivated more for meat production, as mutton and lamb, than for wool, while it cannot be said that until quite recently particular attention has been given to the cultivation specially of meat-producing properties in the Australian merino. Therefore, while utilising inferior merino females for the production of crossbreds, might not special attention by selection and treatment be given to the cultivation of a meat-producing merino, conserving the strong prepotency of the present type, and other special characteristics, peculiar to and so valuable in the Australian merino as a wool producer? The districts in the colonies suitable for the production of such a type might be largely augmented through the cultivation of suitable green crops, roots, selected grasses, &c., which would have to be done in many cases for the profitable production of crossbreds. It is daily becoming more evident that in order to pay our way and be self-reliant we must give increased attention to more extended and better treatment of our vast rich untilled lands, and direct our colonists how with an improved knowledge of the breeding and treatment of stock they may profitably turn their at present almost valueless crops into a more concentrated and portable form, by using them in feeding stock for the production of high-class wool, mutton, beef, dairy produce, &c., suitable for export to the dense populations of the Northern Hemisphere, which, if we cannot induce them to come here, is evidently our course and the way out of our present difficulties.

In order to be successful in the markets of the world, we must endeavour to produce marketable goods of the very best quality; and in doing so we have natural advantages superior to most countries, particularly in live-stock raising; but we must concentrate our energies on moderate areas of land, thereby giving scope for individuality, self-reliance, independent skill and energy, and thus the power of handling more profitably our over-abundant flocks and herds. Weakly constitutioned, injudiciously bred, bad thrivers are a daily drain on the income of their owners, while good doers, vigorous, healthy thrivers are hourly increasing their income; hence, now that live stock may be called a non-liquid asset, unless in condition fit for immediate consumption, it is highly unprofitable to possess and propagate animals that have not the power of assimilating their food so as to turn it readily into a superior product. The days of breeding for numbers, irrespective of quality, to stock up fresh country, or to furnish large musters for purposes of financial arrangements, are over. Quality, not numbers, must now be the aim, and to this end we must acquire a more practical knowledge of what quality consists in, or, in other words, a clear understanding of the requirements of those we wish to enlist as consumers, and also a definite conception of the style of animal best suited for the production of the desired quality. If we are satisfied on these points, and are convinced that we are putting on the European market a first-class article, let us not leave it there to comparatively uninterested business men who, however honourable, need have no special sympathy for Australia, nor desire to benefit us before others, but let us follow it up to see that it gets fair play and is sold straightforwardly to the consumers on its merits.

6.—PREPARATION OF MEAT FOR EXPORT.

By C. T. ALLCUTT.

7.—THE TEACHING OF AGRICULTURAL BOTANY.

By CHARLES T. MUSSON, F.L.S., F.R.H.S.

8.—FLOODS AND FORESTS.

By PHILIP MACMAHON, Curator, Botanical Gardens, Brisbane.

9.—SEMI-TROPICAL HORTICULTURE.

By LESLIE G. CORRIE, Vice-president, Acclimatisation Society; President, Fruit and Economic Plant Growers' Association of Queensland.

10.—FORAGE PLANTS AND GRASSES OF AUSTRALIA.

By FRED TURNER, F.L.S., F.R.H.S.

Section H.

ENGINEERING AND ARCHITECTURE.

1.—EXPERIMENTS ON THE WATERPROOFING OF BRICKS AND SANDSTONES WITH OILS.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney, N.S.W.

The experiments given in the following paper were made with the view of ascertaining the length of time that bricks and sandstone are rendered waterproof or protected by oiling. The oils used were the three commonest and most readily obtainable for such purposes—viz., linseed oil, boiled linseed, and the crude mineral oil known as "blue oil" used for preserving timber.

The weatherings were made upon a flat portion of the laboratory roof, fairly exposed to the sun and weather.

EXPERIMENTS WITH BRICKS.

Good, sound, machine-made bricks, similar to those used in the building of the new Chemical Laboratory, Sydney University, were made use of.

—	No. 1.	No. 2.	No. 3.	No. 4.
	lb. oz.	lb. oz.	lb. oz.	lb. oz.
Original weight of brick	9 0½	8 15½	8 9½	8 11½
Soaked in water for 24 hours... ...	9 10½	9 9	9 6½	9 6½
Increase	0 10	0 9½	0 13	0 11

They were then dried until they had acquired their original weight, when Nos. 1, 2, and 3 were soaked in oil as follows :—

No. 1 soaked in boiled linseed oil
No. 2 ,, raw ,, ,,
No. 3 ,, blue (mineral) oil.

No. 4 was not oiled, so as to serve as a check upon the others.

Date.	Experiment.	Boiled Oil. No. 1.	Raw Oil. No. 2.	Blue Oil. No. 3.	Not Oiled. No. 4.
1889.		lb. oz.	lb. oz.	lb. oz.	lb. oz.
Nov. 12	Original weight	9 0½	8 15½	8 9½	8 11½
Nov. 19	After being soaked in oil for four days the oil absorbed was...	gain 0 9½	gain 0 9½	gain 0 13½	...
Nov. 23	Soaked in water for 24 hours, water absorbed	nil	nil	nil	gain 0 11
Nov. 24, 1889, to June 28, 1890	Exposed on the roof of the laboratory to all weathers for 216 days, the difference in weight was	nil	nil	loss 0 9	loss 0 10
June 28, to Oct. 30	Kept in a dry place for 93 days, and the difference was	loss 0 4	loss 0 2	loss 0 4½	loss 0 1
Oct. 31	In water for 24 hours result	nil	nil	gain 0 13	gain 0 9
Nov. 8	In a dry place for 8 days—difference	nil	nil	loss 0 8½	loss 0 9

They were again soaked in similar oils.

Date.	Experiment.	Boiled Oil. No. 1.	Raw Oil. No. 2.	Blue Oil. No. 3.	Not Oiled. No. 4.
1889.		lb. oz.	lb. oz.	lb. oz.	lb. oz.
Nov. 11	After being in oil for 48 hours, the additional oil absorbed was	0 2	0 2	0 8	not oiled
	or total oil absorbed ...	0 11½	0 11½	0 12½	...
Nov. 11, 1890, to Aug. 5, 1892	Exposed on roof to all weathers for 663 days—result	loss 0 1	loss 0 3	loss 0 8	...
Aug. 6	In water 24 hours—result ...	nil	gain 0 1	gain 0 9	gain 0 9½
1893. Sept. 5	After exposure on roof for 7 months and indoors for 6 months the difference was	nil	nil	loss 0 12	loss 0 9
Sept. 6	In water 24 hours	nil	loss 0 0½	gain 0 11	gain 0 9
Dec. 7	Exposed on roof for 92 days difference	nil	gain 0 0½	loss 0 11	loss 0 10
Dec. 11	In water 96 hours—difference	gain 0 1	gain 0 1	gain 0 9½	gain 0 12½
Dec. 11 to Dec. 31, 1894	In a dry place for 385 days—difference	loss 0 1	...	loss 0 9½	loss 0 14
Jan. 4, 1895	They were soaked in water for 24 hours under pressure of 2½ inches water, wiped with a cloth, and weighed at once, when the weights were	9 12	9 11	9 8	9 7
	Difference	gain 0 1	gain 0 1	gain 0 13	gain 0 14

EXPERIMENTS WITH SANDSTONE CUBES, 8 × 8 × 8″.

These were expressly prepared from the best Pyrmont stone.

Date.	Experiment.	Boiled Oil. No. 1.	Raw Oil. No. 2.	Blue Oil. No. 3.	Not Oiled. No. 4.
1889.		lb. oz.	lb. oz.	lb. oz.	lb. oz.
Oct. 3	Original weight	18 3	18 5	18 6	18 6½
Oct. 3	After being soaked in oil for 15 hours—oil absorbed ...	gain 1¼	gain 0 1¼	gain 0 3½	...
Oct. 30	In water for 24 hours—difference	nil	gain 0 0¼	gain 0 0¾	gain 0 6
Nov. 3	After standing for 4 days (dry weather) -difference	nil	nil	...	loss 0 5½
Nov. 4	In water for 24 hours ...	nil	nil	gain 0 0½	gain 0 5½
Nov. 14	Exposed to the air for 10 days...	nil	loss 0 0¼	loss 0 2	loss 0 6
Nov. 15	In water for 24 hours ...	nil	gain 0 0½	gain 0 2	gain 0 6
1890. July 7	After being exposed to all weathers for 274 days ...	loss 0 1¼	loss 0 1¾	loss 0 1¼	loss 0 6
Oct. 14	After being in a dry place for 91 days	nil	nil	loss 0 2½	...
Oct. 30	Weighed again after 14 days	nil	nil	loss 0 1	...
Oct. 31	In water for 24 hours ..	gain 0 1	gain 0 1	gain 0 2½	gain 0 4½
Nov. 11	After 11 days in a dry place	loss 0 1	loss 0 1½	loss 0 0½	loss 0 4

They were again soaked in the same oils as before.

Date.	Experiment.	Boiled Oil. No. 1.	Raw Oil. No. 2.	Blue Oil. No. 3.	Not Oiled. No. 4.
		lb. oz.	lb. oz.	lb. oz.	lb. oz.
1890. Nov. 12	In oil for 24 hours—oil absorbed	0 1¼	0 1¼	0 5	...
1892. Aug. 4	After being exposed on the roof to all weathers for 661 days, the difference was	loss 0 1¼	loss 0 1¼	loss 0 4	loss 0 0½
Aug. 5	In water for 24 hours ...	gain 0 1	gain 0 1	gain 0 1	gain 0 4½
1893. Sept. 5	After exposure on roof for 7 months and indoors for 6 months—difference ...	loss 0 1	loss 0 1	loss 0 2	* loss 0 5
Sept. 6	In water for 24 hours ...	gain 0 1	gain 0 1	gain 0 2½	gain 0 5
Dec. 7	Exposed on the roof for 92 days—difference	loss 0 1	loss 0 1	loss 0 1½	loss 0 7
Dec. 11	In water for 96 hours ...	gain 0 1	gain 0 1	gain 0 3	gain 0 7
Dec. 12 to Dec. 31, 1894	In a dry place for 385 days —difference	loss 0 1	loss 0 1	loss 0 2	loss 0 4
Dec. 31 to Jan. 2, 1895	In water from 4 p.m. Dec. 31 to 5 p.m. Jan. 2, 1895 (49 hours)	gain 0 1	gain 0 1	gain 0 1	gain 0 6
Jan. 4	They were again soaked in water for 24 hours, when the weights were	18 4	18 6	18 9	18 14
	Weight before soaking ...	18 3	18 5	18 7	18 6½
	Difference	gain 0 1	gain 0 1	gain 0 2	gain 0 7½

* No. 4 was accidentally chipped, and lost ½ oz. in weight.

CONCLUSION

It is noticeable that the amounts of oils and water taken up by the sandstone is very much less than that absorbed by the bricks, although the area of the sandstone cubes is much greater than that exposed by the bricks—*e.g.*, cubes, 8 x 8 x 8 = 512 superficial inches—against 121½ inches exposed by the bricks.

Equal amounts of the raw and boiled oils were absorbed. The blue oil, however, was taken up in much greater quantity by both the bricks and sandstone; but by the end of twelve months the whole of the 13½ oz. of blue oil had apparently evaporated away, and the brick had returned to its original weight, but those treated with raw and boiled oils suffered much less loss.

After the second oiling, in November, 1890, and exposure for four years and nearly two months, the bricks had practically retained all their oil, inasmuch as they had lost only 1 oz. in weight, and were also almost impervious to water.

The blue oil seems to remain and to afford protection from moisture for less than twelve months, so that it is almost useless. If, however, it be more or less charged with the solid paraffins or other solid hydrocarbons, it will, of course, answer the purpose much better.

It is noticeable that the sandstone cubes treated with the raw and boiled oils returned to their original weights between 3rd October, 1889, and 7th July, 1890, and again between 12th November, 1890, and 4th August, 1892 (the one with blue oil, however, being 1 oz. lighter, which may have been partly due to slight chipping and weathering); but, although they returned to their original weights, they do not appear to have completely lost the oil, or its beneficial effects, inasmuch as they only took up 1 oz. of water, whereas the unoiled cube took up 7 oz. of water.

2.—EXPERIMENTS UPON THE POROSITY OF PLASTERS AND CEMENTS.

By A. LIVERSIDGE, M.A., F.R.S., Professor of Chemistry, University of Sydney.

The series of experiments given in the following notes were carried out some years ago with the object of ascertaining which would be the most suitable plaster or cement to be used for the internal walls of the Prince Alfred Hospital, Sydney, then in course of erection. I venture to bring the matter forward, as I am informed that the result may be of use to architects and engineers. No tests were made as to the permeability of the plasters and cements for air and gases; those interested in that question are referred to the researches of Pettenkofer, Marker, Schultze, and others.

RELATIVE PERMEABILITY.

The trials were in all cases made upon slabs (prepared by a skilled plasterer) 6 inches square by ½-inch thick, and finished off on one surface in the usual way for walls, the other surface being as left by the board on which the plaster was worked. The slabs consisted of—

- No. 1. Ordinary plaster.
- No. 2. Keen's cement.
- No. 3. A mixture of half Portland cement and half sand.
- No. 4. Portland cement.

In the first experiment the slabs were placed in rain-water on Saturday, 18th October, and left in soak until Tuesday, the 21st. The water was observed to most quickly permeate the slab composed of half Portland cement and half sand, more slowly through the pure Portland, still more slowly through the common plaster (half each lime and sand), and most slowly of all through the Keen's cement.

The slabs were marked with ink, and it was noticeable that the amount of spreading of the ink (as on blotting-paper) followed the same order as the permeability of the slabs to water.

The slabs were taken out of the water on Tuesday, the 21st, after being in soak for fifty-eight hours—*i.e.*, from 12·30 p.m. on Saturday till 10·30 a.m. on Tuesday. They were stood on end and allowed to drain for ten minutes, and then wiped dry and weighed.

—	Weight, dry.	Weight, wet.	Increase in weight.	Percentage on weight.	After 24 hours' drying. Weight after drying.	Moisture evaporated.	Moisture retained.	Per cent. of moisture retained.
	Grs.	Grs.	Grs.		Grs.	Grs.	Grs.	
Plaster, No. 1	6,665	9,220	2,555	38·3	8,520	700	1,855	21·7
Keen's Cement, No. 2 ...	8,260	8,690	430	5·2	8,250	440	loss of 10 grs.	
Portland and Sand, No. 3 ...	8,450	9,080	630	7·4	8,590	490	140	1·6
Portland, No. 4.	9,780	10,520	740	7 5	10,100	420	320	3·2

After weighing on the 21st instant, the slabs were placed on end round a central support, and allowed to dry in the laboratory, and at a temperature of 70 deg. F.; the results on the 22nd were as above.

—	After 48 hours' drying. Weight.	Moisture evaporated.	Moisture retained.	Per cent. on weight of slab.	After 72 hours' drying. Temp. 69° F. Weight.	Moisture evaporated.	Moisture retained	Per cent. on weight of slab.	120 hours' drying. Temp. 69° to 70° F. Weight.	Moisture evaporated.	Moisture retained.	Per cent. on weight of slab.
	Grs.	Grs.	Grs.		Grs.	Grs.	Grs.		Grs.	Grs.	Grs.	
Plaster, No. 1 ..	8,170	1,050	1,505	18·4	7,780	1440	1,115	14·37	7,730	1,490	1,065	13·7
Keen's Cement, No. 2	8,210	480	loss 50	...	8,210	480	loss 50	...	8,210	480	loss 50	...
Portland and Sand, No. 3	8,530	550	80	·93	8,520	560	70	·82	8,530	550	80	·93
Portland, No. 4 ...	10,030	490	250	2·5	10,000	520	220	2·2	9,990	530	210	2·14

The experiment was repeated with a fresh set of slabs. They were placed in a pan of rain-water on 21st October at 10·30 a.m., removed on 22nd October at 10·30 a.m.—*i.e.*, immersed for twenty-four hours, removed from water, stood on end for ten minutes, wiped with cloth, and weighed.

These slabs, like the former, were wholly immersed and laid flat in the water. In this and the previous experiment, the Keen's cement rendered the water milky and yielded a deposit, and its surface appeared to have been slightly acted upon by solution; this is also shown by the loss in weight which the slab sustained. The others also probably lost something by solution, so that the increased weight is, in all cases, the difference between the loss by solution and the increase by retention of water. Keen's cement, after being wetted and dried, became notably loose and friable on the surface.

—	Weight, dry.	Weight, wet.	Difference.	Per cent.	After 24 hours' drying. Weight.	Moisture evaporated.	Moisture retained.	Per cent.
	Grs.	Grs.	Grs.		Grs.	Grs.	Grs.	
Plaster, No. 1	6,540	9,040	2,500	38·2	8,670	370	2,130	24·5
Keen's Cement, No. 2	8,110	8,510	400	4·9	8,130	380	20	·25
Portland and Sand, No. 3 ...	8,390	9,100	710	8·4	8,710	390	320	3·7
Portland, No. 4	9,830	10,700	870	8·8	10,330	370	500	4·8

—	After 48 hours' drying. Temp. 69° F.				After 6 days' drying.			
	Weight.	Moisture evaporated.	Moisture retained.	Per cent.	Weight.	Moisture evaporated.	Moisture retained.	Per cent.
	Grs.	Grs.	Grs.		Grs.	Grs.	Grs.	
Plaster, No. 1	8,360	680	1,820	21·7	7,580	1,460	1,040	13·7
Keen's Cement, No. 2	8,050	460	loss 60	...	8,030	480	loss 80	...
Portland and Sand, No. 3 ...	8,520	580	130	1·5	8,460	640	70	·83
Portland, No. 4	10,190	510	360	3·5	10,090	610	260	2·6

RELATIVE DURABILITY.

These plasters are intended for indoor use, and thus will not be much exposed to the weather; still a process of disintegration will go on, although at a small rate, and it was accordingly thought desirable to obtain definite information upon this point. The four slabs, one of each kind, were placed simultaneously in a basin of boiling saturated solution of sodium sulphate, and allowed to remain in it for seven minutes; they were then taken out and suspended by strings, over dishes, to catch any fragments which might separate and fall.

Plaster, No. 1.—6,830 grs., fell all to pieces, and was reduced to a mud.

Keen's, No. 2.—8,140 grs., apparently unaffected.

Half Portland, No. 3.—8,370 grs., loosened at edges.

Portland, No. 4.—9,000 grs., apparently unaffected.

RELATIVE ABSORPTION OF ORGANIC MATTER.

Next, to ascertain how much ordinary non-crystallisable organic matter they would take up, fresh slabs were placed in a vessel of hot, weak glue (of the finest quality), and allowed to remain in for forty minutes; they were then taken out, stood on edge, and allowed to dry for twenty-four hours.

—	Original Weight.	Slab and Glue.	Increase in Weight.	Per cent. Increase on Original Weight.
	Grs.	Grs.	Grs.	Per Cent.
Plaster, No. 1	5,960	7,800	1,840	30·9
Keen's Cement, No. 2	8,170	8,330	160	2
Portland and Sand, No. 3 ...	8,660	8,900	240	2·8
Portland, No. 4	8,760	8,870	110	1·3

This test was repeated with fresh slabs. This time the slabs were left in the glue for two hours, and allowed to dry on edge for twenty-one hours; the greater original weights of this set of slabs is due to their having been used in one of the previous absorption experiments with water; the glue also was a trifle stronger than in the previous trial.

—	Weight of Slabs.	Slab and Glue.	Glue taken up.	Glue, Per Cent.
	Grs.	Grs.	Grs.	
Plaster, No. 1	7,580	8,830	1,250	16·5
Keen's Cement, No. 2	8,030	8,200	170	2·1
Portland and Sand, No. 3 ...	8,460	8,710	250	2·9
Portland, No. 4	10,090	10,280	190	1·8

RELATIVE ROUGHNESS OF SURFACES OF THE PLASTERS.

Tests were hardly necessary since the different degrees of roughness were quite apparent to the eye and touch, but the following experiments were made to obtain, if possible, numerical values for roughness. The surfaces were well rubbed in with red lead to represent ordinary dust and dirt. Red lead was chosen because it is heavy and renders the increase in weight more appreciable; and, secondly, because the adherent pigment is at once apparent, and the depth of colour shows the relative amount of powder retained by the roughness of the surface.

—	Weight.	Plus Red Lead.	Increase in Weight.	—
	Grs.	Grs.	Grs.	
Plaster, No. 1	7,415	7,420	5	per 72 inches superficies.
Keen's Cement, No. 2...	8,080	8,080	0	...
Portland and Sand, No. 3.	8,520	8,530	10	or twice as much as Nos. 1 and 4.
Portland, No. 4... ...	9,905	9,910	5	...

Again, so as to make the surface take up as much as possible, the red lead was rubbed in and the excess scraped away with a cork, and the loose powder blown off, when the following numbers were obtained for the two rougher materials; it was thought unnecessary to make further trials with the other two:—

	Grs.	Grs.	Grs.	
Portland and Sand, No. 3	8,520	8,600	80	or 16 times as much as No. 4.
Portland, No. 4... ...	9,910	9,915	5	...

After rubbing off as much of the red lead as possible by means of a dry cloth, the Keen's cement was of a pale-orange colour, the plaster of an orange colour, the Portland of a red colour, and the half Portland of a bright-red colour.

These colours agree with the roughness apparent to the eye and to the touch in the following order:—Keen's, plaster, Portland, half Portland, this last being the roughest of all.

CONCLUSION.

From the foregoing experiments Keen's cement appears on the whole to be the best for indoor work, but it is not adapted for outdoor use unless painted, since it is to a certain extent soluble in water. It takes up less water, less organic matter as represented by the glue, than others, and practically no dust; further, it is more resistant to the action of crystallising sodium sulphate; but Portland cement, if painted, would be even superior to it on account of its greater hardness and durability.

3.—ADDENDUM TO PAPER ON WIND PRESSURE IN VOL. V. OF AUST. ASSOC. ADV. SCIENCE, P. 573.

By Professor W. C. KERNOT, M.A., C.E., F.R.G.S.

In my previous paper on wind pressure certain important points were left to some extent in doubt, my methods of experimenting not being sufficiently perfected to give thoroughly reliable results. During the past year I have succeeded in constructing improved apparatus, and obtaining therewith results that I consider satisfactory.

The first point left in doubt was the relation between velocity and pressure. The general formula is—

$$P = c\, V^n.$$

But considerable difference of opinion existed as to the values of c and n. Taking P as pounds per square foot, and V in miles per hour, values of c had been given varying from ·0035 to ·007, ·005 being that generally adopted on the authority of Smeaton, and n was generally on the authority of Newton, confirmed by the experiments of Rouse, taken as 2; while Crosby, aided by most costly and elaborate apparatus, maintained stoutly that it was unity. (*See Engineering*, 13th June, 1890, p. 716.)

In my previous paper experiments are described made with a blowing machine and an Osler anemometer, and also with an Osler anemometer carried on a bicycle. The former of these were unsatisfactory owing to the difficulty in measuring the exact velocity of the air, and the latter owing to the speed being simply estimated, not accurately measured, and the experiment being made out of doors, where the atmosphere itself was always to a greater or less extent in motion.

The recent experiments were made with a whirling machine, in some respects an improvement upon that used by Crosby. It consisted of a strong radial arm, fixed to one end of the crank shaft of the gas engine at the engineering laboratory at the Melbourne University. Along this arm ran an axis, suspended between centres, so as to move with as little friction as possible. At the outer end of this axis a lever was attached, parallel to the shaft of the engine, carrying a piece of stout cardboard 8 inches by 4½ inches, or exactly one-quarter square foot area, the pressure against which was measured. At the inner end of the axis a second and much shorter lever was attached, at right angles to the first, the free end of which was exactly in the centre line of the crank shaft of the engine. To this was attached, by a ball and socket swivel joint, a wire leading to a delicate and carefully calibrated spring balance, by which the pressure on the card was measured. Thus the pressure could be read at any moment without stopping the engine, as was necessary with Crosby's apparatus, illustrated in *Engineering* of 13th June, 1890, p. 718.

With this apparatus twenty-three experiments were made, with linear velocities of from twelve to twenty-seven miles per hour, as per table below:—

No. of experiment.	Velocity in miles per hour.	Pressure in lb. per sq. ft.
1	12	·29
2	12	·47
3	12	·56
4	12·8	·65

No. of experiment.	Velocity in miles per hour.	Pressure in lb. per sq. ft.
5	14·6	·65
6	15	·77
7	15·9	·79
8	17·2	·68
9	17·2	·97
10	17·6	1·13
11	18·2	1·07
12	19·3	1·13
13	19·8	1·41
14	20·4	1·36
15	21·4	1·57
16	22·3	1·90
17	22·7	1 74
18	24·4	1·97
19	24·6	1·78
20	24·6	2·02
21	25·7	2·06
22	25·7	2·15
23	26·8	2·24

These results, though presenting occasional anomalies due to the defects of the apparatus and imperfect observation, correspond very fairly with the formula,

$$P = {\cdot}0033\ V^2,$$

which differs very little from Dines' formula,

$$P = {\cdot}0035\ V^2,$$

referred to in the previous paper, and are utterly irreconcilable with either Crosby's or Smeaton's, as is shown by Fig. 1, where the experiments are shown by dots and the various formulæ by lines.

It should here be mentioned that the observed pressures were all increased by 10 per cent. to allow for *mit-wind*, or the general motion of the air in the room due to the action of the apparatus and friction of the mechanism. In doing this the example of Crosby was followed, whose reasons are fully given in *Engineering* of 13th June, 1890, p. 716. If this allowance be not made the formula will become,

$$P = {\cdot}003\ V^2.$$

I regret that the position and construction of the gas engine prevented my extending the experiments to higher velocities.

The next point left in a not thoroughly satisfactory state by my previous experiments was the effect of variation of angle of incidence on the normal pressure. The old apparatus, which consisted of a plane surface mounted on a carriage, had a tendency to overturn when the incidence was very oblique, and gave uncertain results. The new apparatus consists of a plane surface attached to a balanced lever having a firm but nearly frictionless axis. This axis can be placed at any required angle. The motion of the plane is prevented by a thin cord leading to a spiral spring, and passing on its way round a small freely moving pulley on the axis of a small flywheel. This latter arrangement was found very useful to check oscillations due to momentary gusts in the current of air from the blowing machine described on p. 577 of Vol. V. of the Trans. Aust. Assoc.

The plane surface was 10 inches long and 6 inches wide.

With this numerous experiments were made at angles of incidence varying from 90° to zero with very consistent and satisfactory results, which are shown in Fig. 2, in comparison with the results of other experimenters, and are further stated in the subjoined table :—

Angle of Incidence.	Normal pressure according to Hutton.	Duchemin.	Crosby.	Kernot.
10°	24	34	10	28
20°	46	61	...	51
30°	66	80	37	72
40°	83	92	..	83
50°	95	99	68	90
60°	100	100	...	95
70°	100	100	91	98
80°	101	100	...	99
90°	100	100	100	100

The above figures are in the case of Hutton and Duchemin taken from Professor Warren's *Engineering Construction*, p. 286, and in the case of Crosby from *Engineering* of 6th June, 1890, p. 690.

An inspection of Fig. 2 will show that the results I have now obtained when plotted give a much more regular curve than those of the other authorities mentioned, a fact which should, I think, be taken as greatly in favour of their probable accuracy. In the most useful part of the range, that corresponding to ordinary roofs, they are very nearly a mean between Hutton's and Duchemin's.

In the previous paper, p. 579, it was pointed out that in ordinary buildings in which roofs are combined with walls, and occasionally parapets, the wind is deflected upward and away from the roof, and the normal pressure largely reduced. A considerable number of further experiments have been made to illustrate this point, and all have emphatically vindicated the conclusion that a roof supported on walls experiences very much less pressure than one supported on columns only, and under which the wind can pass freely. A number of experiments with small flags were made to determine the curve taken by the air current passing the top of the wall, with the result given in Fig. 3, where, if the height of the wall be unity, the distances AB and BC are ·5, while BD is ·5, CE is ·75. Above the curve ADE the full current is felt, but below it are only eddies or nearly still air. The pressure upon any roof not rising above ADE will therefore be but an insignificant fraction of what has been hitherto supposed. Thus the limit of what has been called the "wind shadow" is accurately defined. It was notable how very definite was the curve ADE, within and without which the behaviour of the little flags was entirely different.

With the aid of the apparatus used to obtain the results shown in Fig. 2, numbers of experiments were made as to the wind pressure on roofs with and without walls, and the general results of the paper of 1893 were confirmed. In the case shown by Fig. 4, the following table gives the conclusions :—

Angle of roof to horizontal.	Normal pressure: Without any wall.	With wall. AB = 1¼ BC.	With wall. AB = ½ BC.
60°	95	55	75
45°	87	25	55
30°	72	10	14
20°	54	0	0

The pressure on a vertical surface being 100, the presence or absence of the other slope of the roof CD did not perceptibly affect the result.

Next the roof shown in Fig. 5 was tested. In this BC=CD=EF. The angle of slope is 30°, and the point E is at the same level as C. It was found that, the pressure on a vertical surface being 100, that on EF is 10 if DE is closed, and 20 if DE is left open.

In Fig. 6 the upper portion of the roof EF is on the same straight line as BC, the angle as before being 30°. Here the pressure on EF was 15 when DE was closed, and 45 when DE was open.

Fig. 7 represents an experiment to determine the amount of shelter a roof received from a precisely similar roof windward of it. As might naturally be expected, the shelter was practically complete, the pressure on EF being too insignificant to measure.

Figs. 8 and 9 represent experiments to determine the wind pressure on a veranda of ordinary proportions connected with a one and two storied building respectively. In Fig. 8 no pressure either upward or downward could be measured at a slope of either 30° or 45°. In Fig. 9, at 20° slope, no pressure was recorded, but at 45° the top of the veranda experienced a pressure equal to 20 per cent. of that on a vertical surface.

In Figs. 4, 5, and 6 a moderate projection of the eaves over the wall did not appreciably alter the result, but if the wall projected as a parapet above the junction of the roof, the pressure was always reduced, and with the flatter pitches sometimes rendered negative.

The foregoing investigation confirms Dines' formula connecting velocity and pressure, and controverts Crosby's and Smeaton's. It gives a probably more accurate representation of the effect of varying angle of incidence than either Duchemin's, Hutton's, or Crosby's. It gives the outline of the "wind shadow" of a wall within the limits of which the wind pressure is practically inoperative, and it supplies data for computing the effect in pressure on certain commonly occurring arrangements of roofs and verandas, in connection with the walls of buildings, which, as far as I am aware, have not been previously studied or intelligently treated.

It is to be admitted that the experiments have all been on a comparatively small scale, and that the velocity range has not been very large. The apology for this is limited time and restricted facilities. Unquestionably it is most desirable that some person or body possessed of ample time and funds should repeat them on a tenfold larger scale, and with the utmost attainable precision. As Crosby says at the close of his paper, "The cost of determining formulæ true beyond any question would be repaid many times every year in applying them to the true economy of engineering structures."

NOTE.—During the above experiments the barometer read approximately 30 inches, and the thermometer 70° F.

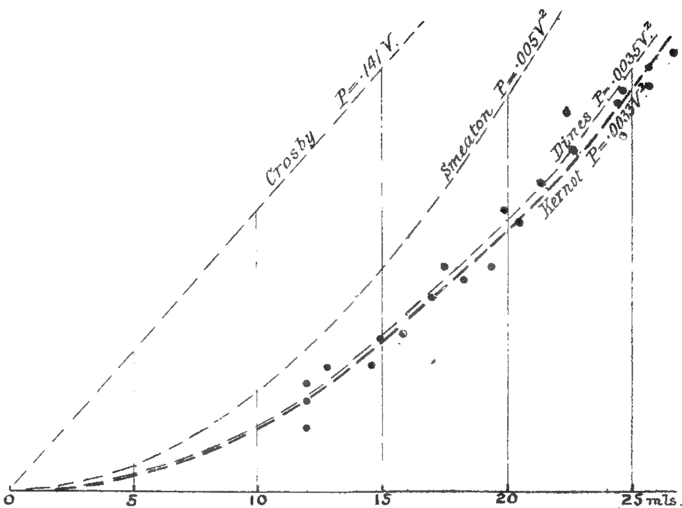


Fig. 1.

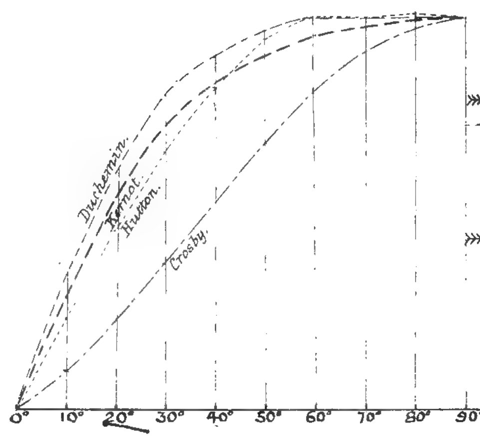


Fig. 2.

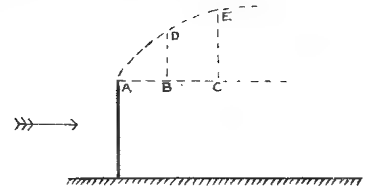


Fig. 3.

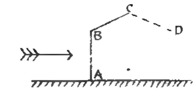


Fig. 4.

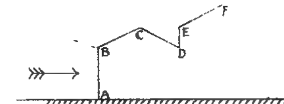


Fig. 5.

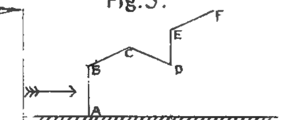


Fig. 6.

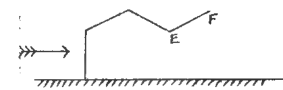


Fig. 7

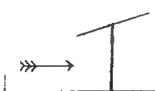


Fig. 8

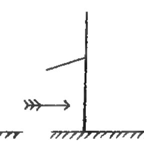


Fig. 9.

W P K

4.—ARCHITECTURAL SCULPTURE.

By PERCY F. HOCKINGS, A.R.I.B.A.

The title I have chosen for my paper, "Architectural Sculpture," is a short one, but indicates a very large subject. It is a subject, moreover, which unfortunately is not thought equally important in the two branches of work represented in this section, and tends rather to theory. I think, however, that the subject is worthy of attention from both engineers and architects, and so have tried to seize and illustrate some of the general principles in this field of art, which is too little regarded as an integral part of our work.

I use the term "Architectural Sculpture," as distinguished from gallery work, to include all sculpture designed for the decoration of buildings, and I wish to include those works in clay and metal, which, though they are not sculpture in the strict use of the term, are used to the same end and are governed by the same considerations.

The so-called gallery sculpture is work which is designed to be looked upon as complete in itself; and, either through over-finish or want of scale, does not harmonise with its architectural surroundings, thus throwing aside the true office of sculpture, that of decoration, and aiming at *independent* rank.

The distinction between the two is a comparatively modern one, for until late Renaissance times there was no real gallery sculpture produced; and sculpture held its place at the head of the other decorative arts—painting, carving, inlaying, and casting. For in former periods architecture was rightly recognised as the *alma mater* of all the arts; and it was recognised also that perfect work could only be produced by a judicious combination of the whole. All the arts are allied, but the connection between architecture and sculpture is more natural and effective than between architecture and any of the others, for the materials used are in most instances the same, and sculpture is quite part of the mother art.

The most natural way to approach our subject is by studying the treatments presented by designs of former times, in order that we may see the forms architectural sculpture has appeared in, and the uses to which it has been applied. Then, having investigated the bases upon which the designers worked, and the limitations which they recognised, we may formulate canons for our future guidance.

Beginning, then, with the rude scratchings found among the records of all nations, we find little of use to us before Egyptian work, the best of which was produced about 3000 B C. In this the most admirable point is the harmony between the stiff conventional figures and the simple severe architecture of the period, adding greatly to its impressiveness and interest. After a long decadence Greek work comes under our notice—the early efforts following Egyptian models, but, after a couple of centuries of development, arriving at a state of practical perfection under Phidias about 430 B C. The careful adjustment of conventionality and grace, and the improved modelling, suited well the exquisitely delicate architecture of the period; and we may also note, in passing, how the angularity, the determined use of the straight line, is retained, and how well it accords with the rectilinear architecture.

In the Roman period which followed we find a want of refinement in conception and execution; although in its vigour and bold assertiveness it suited well the people and buildings of the time. After the Augustan age, refinement lost ground; and from 500 A.D. everything of beauty, sculpture included, went from bad to worse for centuries: nothing very worthy remains.

But the dreaded year 1000 having passed by without universal dissolution, the Gothic spirit pervaded all lands with new hopes and new artistic life; and although the work was restrained and severe at first, it gained more freedom in unison with the developing architecture. It produced a too great realism about 1350, especially in France and England, and then reverted to moderation. As a whole, the period produced much good work all over Europe—full of the love of nature, earnestness, and fancy, and admirable both in scale and treatment.

The sculptors of the next period reverted to classical principles of design; but, by taking advantage of the freedom and variety in design born of centuries of study of Nature during Gothic times, they were enabled, with their improved technique, to produce a wide range of exquisite work, especially in Italy during the 15th and 16th, and France during the 16th and 17th centuries. During this period low relief was especially developed to a very high standard; the prominent qualities of the work of the period being individuality of expression and delicate suavity of modelling.* Fig. 10 is an example by Donatello.

And now again, after an almost unbroken lapse of a couple of centuries, really good work is promised us by the present revival visible in France and America, but especially in England; although of course a great period would be practically impossible under our social system.

We notice in each case how the arts as a whole grow and decline with the strength of a nation, and also how strong an influence the social milieu—the surroundings and sentiment of the age—has upon the work of sculptors. Note in this respect the conventionality of the Egyptian work, and remember how conventional their life is said to have been. Turning to the Greek, we are forced to remember how they worshipped perfectly trained athletic strength and grace: the gods only more handsome and more strong than the men. Then passing swiftly to Gothic, how the devotion and love of Nature displayed take us back to those dark ages when the world was really a vale of tears and ignorance: the Church seemed man's only hope, and Nature was seen to mirror God's goodness. Again, after this, it is easy to see the Christian spirit pervading the early Renaissance work, and the Pagan spirit pervading the late.

Seeing, then, that surroundings have such an influence, let us fill our minds and hearts with the sentiments and ideas of our age, and prove how well we can work, having studied the forms and the uses to which former workers have put sculpture, and having good technique already to our hands.

First, then, with regard to the forms that architectural sculpture may assume, it is evident that different types of buildings necessitate

* This paper was illustrated by the exhibition of 30 diagrams, of which 12 are shown in the plates.—*Editor*.

varying treatments; and to satisfy this demand we find sculpture in two main forms as statues or as relief, each available in infinite variety.

Then, again, mouldings may quite correctly be added, for, although they are the most modest form of sculpture, they are of very great use, for even where the higher forms are used on the same building the grace and relief given by well-designed mouldings exert a powerful influence for good.

Good mouldings alone are quite sufficient on buildings of great severity or modest pretensions without further additions in the shape of foliage or figures. It will be found that the mouldings enclosing higher forms of sculpture play an important part in giving the key of sculptural colour to all they enclose, their straight lines accentuating the curved lines of the sculpture in the panel, besides effecting a gradation of light between the enclosed sculpture and the plain wall. As examples of these points I would direct your attention to Plate 1.

In flat relief the plain wall-space plays an important part, the effect of relief being gained by incised lines. And it has been found that, in sunlight, square sunk lines are more effective than V-shaped ones; and also it is proved advisable that those lines which approach verticality should be cut deeper. This form is most suitable for use upon hard material, and where severe and conventional forms are represented.

Used as surface decoration bass-relief is the most useful, and perhaps the most beautiful, form of architectural sculpture. It may be used in almost any position, and will still fulfil its duty of adding interest and beauty to the building. It is, however, specially suited to half-light, as there no sunlight can penetrate the sinkings to the destruction of the shades, and there again it is found that a slight additional depth of cutting is effective. An exquisite example of this form is presented by the Panathenaic frieze of the Parthenon at Athens, where the greatest projection is $2\frac{1}{4}$ inches. The example is, of course, well known—the gods, the supple heroes, the beautiful women and horses, &c. A fragment is shown in Fig. 3, Plate 2. Many more modern examples might be given; good, but not so good—some Gothic, many Renaissance, a few of this century.

Sculpture in full relief is found as terminal statues, or in niches on the wall-face. This form is most useful in actual sunlight, the deep cutting giving the desired light and shade. We find figures in pediments and other such positions, in high or full relief, and generally protected from weather by cornice or canopy, which accentuates the projection of the sculpture by shading the background. In all forms broad treatment should prevail so as to avoid a spotty effect.

Of course the whole range of architectural subjects is open to adoption in each of the above forms, but observation and reading have led me to the opinion that inanimate objects, and subjects taken from the lower planes of life, are only fitted for presentation in the "flatter" forms of sculpture. The lower the subject in the life scale the more conventional and the "flatter" should its treatment be. A modest yet striking example is seen in Fig. 5, Plate 5. The snake, being a higher form, its modelling is carried further than the foliage.

Secondly, as to the uses we find architectural sculpture put to, they are numerous. The chief is the addition of beauty, life, and variety of texture to the whole building by contrast with the plain surfaces, as shown by Fig. 14, Plate 4.

The completion of the outline of the main masses, as in Fig. 6, Plate 3, is a small matter, and the giving relief to the skyline, at times perchance too much relieved. Sculpture should also express the character and purpose of a building. There are several such schemes in London satisfactorily treated, being both interesting and decorative—one, a frieze over a hatter's shop, illustrating hat-making; another, over a baker's shop, with little urchins all along it making biscuits and bread.

Sculpture may also be used to record the deeds or the notable events in the lives of people connected with a building—the patron saint of a church, for instance, or the founder of a school; or, again, the history of a town and great events of civil interest would suit well a town hall.

The creation of readable interesting subjects is a matter of vital import; for now that phonetic language has replaced the figurative to an extent, sculptural symbolism is read by few. Books are looked to more and more for descriptions and records of events, and symbolical subjects not being understood are found uninteresting. Some symbols have by continued use, however, become quite part of ourselves, and the fact that their presence upon a building gives a subtle pleasure to those who do read them, is, I think, quite sufficient argument in favour of their continued use, putting aside the fact that they would decorate the building and relieve its masses, even though unappreciated and unread. I may cite as an example Fig. 8, Plate 3. Here the very few ignorant observers would see only a winged bull in a very awkward position. How different the thoughts of all those who understand the symbol. They would recognise a chief light of the Church, placed there on the buttress as a guide and example to remind passers by of the life lessons preached so ardently by the great Apostle.

It would of course be preferable as a rule to adopt subjects everybody could read and be interested in, for it is the capability of telling a story in so noble a material that is the glory of sculpture, for sculpture at its highest has more than decorative qualities; it has a moral to teach, a memory to recall, an individuality to record.

Now let us turn to the design and execution of sculpture. Here I find it convenient to divide my subject under half-a-dozen minor headings, in order that I may the better enforce certain guiding principles and helpful truths founded on experience and the study of old work. Attention to such does not restrict the artist's powers, but directs his efforts worthily and guards him from irregularities; for they are, as Ruskin says, not only safeguards against error, but the source of every measure of success.

The first heading I shall speak under is *restraint*. This is one of the most important elements of design, yet one of those most frequently neglected. Do not be too lavish, keep the work small, and keep it flat. The most common contraventions of this principle may be traced either to an anxiety for lavish display, leading the designer to introduce an excessive quantity of sculpture, thereby giving a disagreeable fussiness to the building. Too great action or exquisite finish afford other opportunities for the exercise of restraint, the latter giving the idea that the architecture is but a frame to hang sculpture on. Too great projection is another common sin, proving that the designer has not carefully considered the light and scale of the work. The presence of a little restraint in a design gives an evidence of power and reserve of artistic strength in the designer, whereas a lavish display points to the fact that he has entirely expended his capacity on the work, which is bad.

The second principle I shall urge is the necessity of *harmony*. It is essential that the sculpture should harmonise with the feeling and intended use of the building—that it form an integral part of the design, and not in the least suggest itself as an afterthought stuck on. This effect may be gained by careful adjustment of surrounding mouldings, and by keeping all work in panels, &c., flat. But by far the easiest way to gain harmonic effect is to allow of no unnecessary ornament. Let none be present for its own sake. Let every cut be part of the design to accentuate its simplicity, stateliness, or richness, as the case may be. If an exceedingly rich effect be aimed at, the sculpture should be harmoniously distributed throughout the composition. Hotel Bougtheroulde, Rouen, is an example. Here the building and the subjects are propitious to the type of treatment, yet the effect is wanting in nobility, and tends to fussiness as before mentioned. Another vital point embraced by this principle is that the constructive lines of a building must never be interfered with by the sculpture, for, when they are obscured or covered, chaos and want of harmony result. Harmony must also be maintained between the figures or various parts of a composition as well as between the sculpture as a whole and the building.

Next I would ask your attention to *light and shade*. Here a point I wish to urge is that sculpture should always be in a higher key than the surrounding architecture; that is to say, it should be lighter. Look to Fig. 14, which is an excellent modern example of every good point. It is, of course, only a drawing, but illustrates my point. The Greeks valued this point, and gained the effect generally by keeping the sculptured surfaces broad and flat, occasionally by selecting lighter coloured stone for the sculpture, and frequently they went so far as to colour the tympana of their pediments. Then there is another point closely related to this namely, all spaces designed for sculpture must be filled up with precision to the circumscribing lines. If this is not attended to, great confusion will result, for the uncovered background will assimilate with the plain surface outside, and so destroy the composition.

Before commencing work, the designer should have a complete knowledge of the position of his work and the light obtainable for it, so that he may determine the form he will use, and the amount of finish he may legitimately bestow. Of course external architectural sculpture should never be finished to the same perfection as internal and gallery sculpture, for then it would disrate the architecture, besides being lost on most of those who saw it. Indeed, finish should be carried only so much further than mere representation necessitates as to give an extra pleasure to anyone taking a second look. Further work is lost.

On the other hand, neglected detail is often more offensive than that excessively finished, by reason of its want of harmony and its rudeness.

Materials.—Much might be said of *materials* themselves. Of course white marble is looked upon as the ideal, but much admirable work has come down to our time executed in coarser stones, metal, and clay, both glazed and unglazed. These are all procurable in Australia, so I feel sure the materials will not be found wanting when the designers and workmen and the desire for beautiful work are born amongst us. Sculpture cannot look better than when executed in the same material as the building itself. If some other be desired, let the choice be of richer material—stone on a brick building, marble, or metal on a stone one. In all cases the treatment should conform to the nature of the material worked in; for instance, clay and metal should have quite a different treatment to stone. It is in this direction that moderns, since the time of late Renaissance, have commonly failed. The deeply cut and flowing draperies continually seen remind us of the fact that they have been worked from clay models, and are not suitable for execution in stone.

Again, the limitations of the material must be recognised, and compositions must be restricted to one plane. Perspective and distance, such as Ghiberti and many smaller men have tried for, are beyond the range of sculpture. As regards leaves and foliage, never try in stone to emulate the delicacy obtainable in metal or even in wood, but let the stone govern the execution. The hardness of stone occasionally regulates its treatment; see, for instance, how flat and conventional the sculpture, if any, and how simple the mouldings worked in granite.

Repose and balance are very desirable qualities in sculpture. Far better err on the side of quiet reserve than allow a suggestion of fussiness, especially in the lower forms, as in foliage and draperies. Of course, an expression of growth in foliage and of life in figures is desirable so as to avoid meagre, straggling effects in the one, and stiff perpendicular effects in the other; but it will be found easy to give an impression of unrest by exaggerated action, which will clash with architectural surroundings, besides distressing the mind with the fear of instability.

On similar grounds I should be inclined to question the propriety of using caryatides and similar forms. The more finished and natural, the worse they look. A conventional treatment and a calm, noble face, however, rectify the evil to an extent.

Equilibrium is especially necessary to terminal statues against the sky, where, the profiled mass alone being seen, the slightest want of balance is noticeable.

Sobriety is often accentuated by facial expression, the face being such a readable index. The Greeks evidently recognised this, as we find the stolid nobility of a good natural type continually portrayed in their work. Such refinements, however, should only be resorted to in special cases, and where mere representation has proved insufficient.

The next point for consideration is *scale;* the most important factor to be appreciated in respect of it being that magnitude is relative rather than actual, so that by carefully proportioning the parts and details with which the eye is acquainted (the human figure, for instance, will readily and naturally apply) a fictitious scale may be given. In such a case harmony of scale in the component parts is more than usually necessary, otherwise the effect of the whole will be destroyed, and the aim for additional nobility and size not only frustrated but also exposed. Then, again, care must be taken that the size and intensity of the sculptured masses accord with the scale of masonry used, for otherwise the sculpture, as a whole, is likely to appear too light or too heavy for the building.

Known examples of bad scale are common enough. In Nelson's Monument, and Sansovino's Giants, Ducal Palace, Venice, the sculpture is too large. In the façade of Certosa de Pavia (Fig. 20, Plate 4), and in the Montawk Club the sculpture is too small.

Examples of good scale are also easy enough to name in all periods, from the Greek through Gothic and Renaissance, represented by Sansovino's Library (Façade), to the Chartered Accountant's Building (Fig. 14) of to-day.

Close observation of pleasing and unpleasing examples and individual taste are the only guides on this question of scale. One point, however, seems certain, and that is: It is better to keep figures on ordinary buildings well under life size. In this connection the following figures may be of service and interest:—

24 feet from ground, 3 feet 9 inches bass-relief looks proportionate—Pistoja Hospital.

30 to 35 feet from ground, 4 feet 6 inches to 4 feet 8 inches bass-relief—St. Mark's Library and Chartered Agents; whilst 2 feet looks very small on Montawk Club.

55 to 60 feet from ground, 6 feet looks all right, 7 feet looks big.

72 to 80 feet from ground, 7 feet 6 inches looks all right.

101 feet from ground, 12 feet a shade big—about 14 inches.

150 feet from ground, 18 feet 6 inches looks too big by 3 feet.

Thus you see that *position* regulates scale in the various parts, and it also regulates the amount and distribution of finish.

The position from which sculpture will be seen also exercises a powerful influence in its design, largely determining the finish and foreshortening. Take, for instance, a piece of sculpture at a height of 30 feet which will be seen from a position almost vertically below it. Here the lower portions must be set back so as not to cover the upper. The lower faces should be better finished than the rest, and the limbs, if figures are used, must appear correct from the point of sight, though not necessarily anatomatically correct.

The central figure (Fig. 25) illustrates this point with its foreshortened thighs at an obtuse angle with its body and legs, giving the idea of a sitting posture, whereas had the figure been seated correctly the knees at that height would have hidden the rest of the body, and so represented the figure as a deformity from our standpoint.

The position of the several figures of a composition is also a point for serious consideration, the centre, of course, being the place of honour and interest.

These guiding principles, though I have spoken of them separately, are all intimately connected, so much so that I have found myself speaking of harmony under scale, of restraint under repose, and scale in masonic treatment and materials, whilst others may have been passed without special remark. Our aim should be to evolve, in accord with them, new, beautiful, and fitting combinations, sympathetic with our architecture, taking Nature as our guide.

In designing after Nature, I may mention that perfection is not to be attained by mechanical imitation of a single specimen of a species, but by emphasising the essential qualities of the species as a whole; and the higher the form stands in the natural world which we are depicting, the nearer to Nature we may work without fear of o'erstepping the bounds of good taste. Thus we find in the best periods the human form presented more perfectly than is the average found in Nature, though still considerably conventionalised.

Money restriction is a matter which we have continually enforced upon us in actual work, and consequently it influences strongly the treatment of architectural sculpture. It seems only natural that it should in this age; but a sad case is that in which a second-rate sculptor is chosen to execute the work because he will do it for less money than others, his enthusiasm most likely being crushed at the outset by being obliged to copy the architect's designs, which are themselves restricted by conflicting instructions. How can good work be produced under such conditions? Upon consideration of such a case, it is evident that a sculptor must not be tied down to copy exactly the design of another individual, for by the absence of spontaneous individualism in the worker all hope for spirit in the work is lost. The sculptor must have fresh inspiration for each part of the work, for the whole soul of the thing depends on the attitude of his mind at the time he is cutting the stone: the ideal arrangement being to get the component parts of sculpture and architecture massed out in a pliable state, and to combine them at an early stage of the designing, so that the whole may be developed and completed as one conception. To reach this ideal it is necessary to co-operate with the sculptor from the outset.

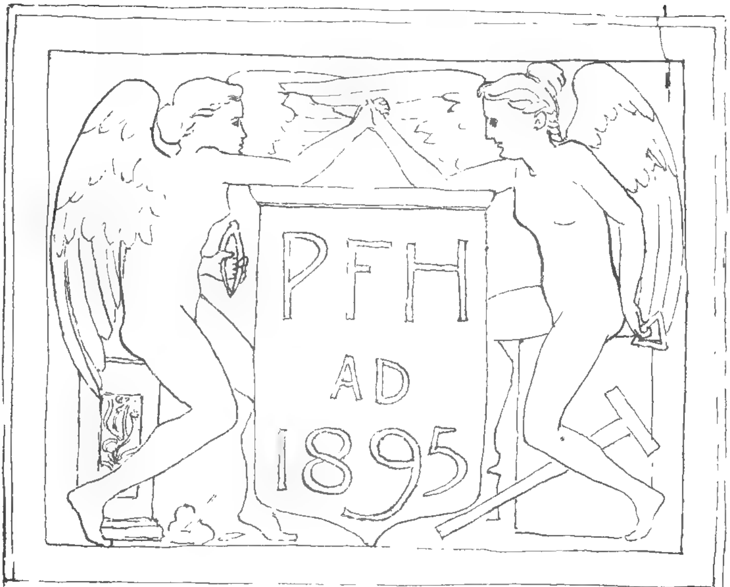
In the representation of modern dress, the sculptor is said to be heavily handicapped, for, excepting in the robes of State and learning (so the question goes), wherein lies the beauty of modern male attire? Where the lines of beauty in frock coat and tall hat? They are hard to find, so let us look elsewhere; let us look to other specimens of the race.

Good illustrations of human life and labour, love or passion, will always interest humanity. Note the aprons of canvas and leather, the knee-tied trousers, the baggy shirt, the rolled sleeves of the labourer; note caps, blouses,and overcoats. Then let us not forget the introduction of a full complement of female forms, for have we not grace here and variety in plenty. On the whole, we are not so badly off as we are led to believe in this matter of dress, for there seems a sufficiency of good before us in the forms mentioned to allow of the omission of the bad, and still to leave a good selection of *motifs*.

It is the gentlemanliness of the modern gentleman's dress which is so very hard to treat; but even this does not look so fearful in the Albert Memorial. (*See* Fig. 25, Plate 2.)

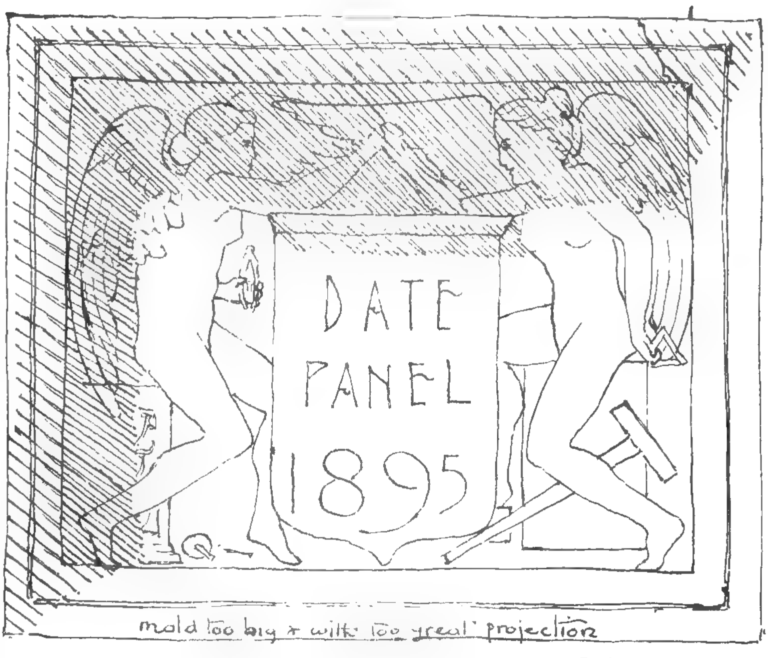
In the design of foliage, the stalk is always a trouble to finish satisfactorily. The best way is either to merge it into the background, as in Fig. 5, or to hide the end under leaves, the stem itself being used to give the vital lines and flowing curves of the composition. (Plate 5.)

PLATE I



Influence of mold on Panel — spaces filled.

FROM CLAY EXAMPLES



mold too big & with too great projection

P. J Hockings.

PLATE 2

FIG 25

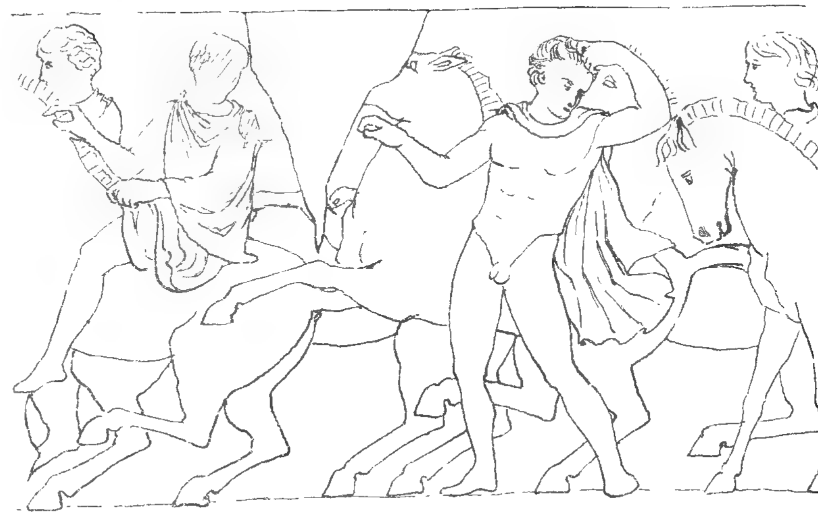


FIG 3

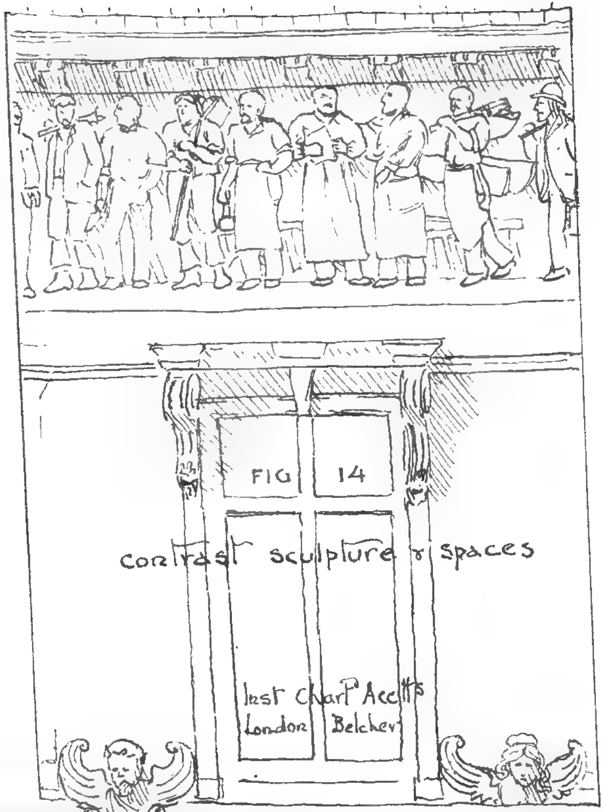
PLATE 3

FIG 8

FIG 6

FIG 10

PLATE 4



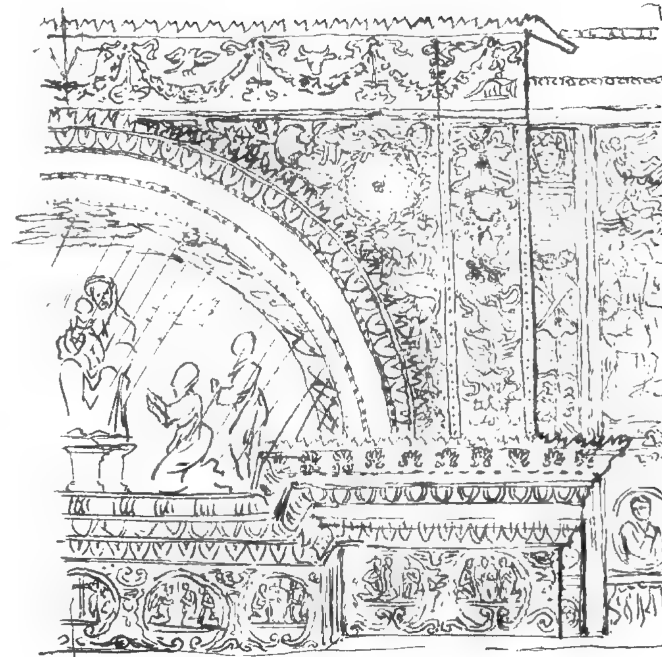


FIG 20
overladen – too delicate

PLATE 5

FIG 26 A

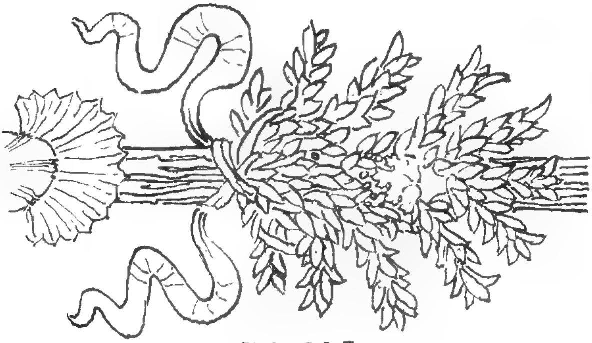


FIG 26 B

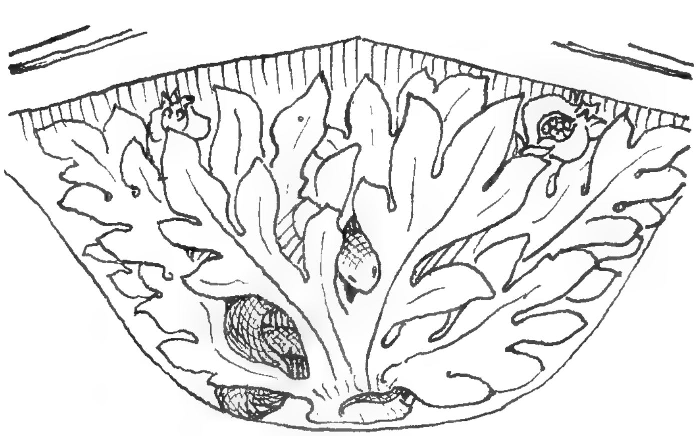


FIG 5

The designer cannot make too many studies; but there is one thing to be guarded against, and that is being encumbered by them. The road to success being by the rule, never design with either Nature or your studies before you, the actual thing being not malleable enough for use; but study well your subject and studies; then, putting them aside, you will find that your impressions adapt themselves with surprising ease to your purpose. Make studies continually, for, insomuch as invention or design is little more than a new combination of those images which have been gathered and deposited in the memory, it is evident that a great part of every designer's life must be employed in collecting materials for the exercise of his genius.

Nothing can come of nothing; he who has not laid up materials cannot produce combinations.

I will now draw my paper to a close, not because I have exhausted the subject, for I find it vast as it is interesting, but for fear of wearying those of my hearers who may be less interested in it than myself.

5.—TEREDO-RESISTING RIVER WORKS.

By THOMAS PARKER, C.E., Rockhampton, Queensland.

THE TEREDO.

The name locally given to the *Teredo* is the Cobra; in other localities it is commonly know as the ship-worm. Its place and work in the economy of Nature appear to be that of a river and sea scavenger, and it performs a useful work generally in clearing away the large quantities of drifting timbers in the rivers and seas, especially of warm climates, as this timber, if not destroyed, would otherwise accumulate in large quantities and choke up the waterways.

The following description of the animal is from L. Figuier:—"The singular acephalous mollusc, known to naturalists as the *Teredo*, has the appearance of a long worm without articulations. Between the valves of a little shell, with which it is provided anteriorly, may be seen a sort of smooth rim, which surrounds a swelling projecting pad or cushion. This cushion is the only part of the body of the animal which can be regarded as a foot. Starting from this point, all the body of the *Teredo* is enveloped by the shell and mantle, the latter of which forms a sort of sheath communicating by two siphons with the exterior. The *Teredo* lays a spherical greenish egg. Shortly after fecundation these eggs are hatched. At first naked and motionless, these larvæ are soon covered with vibratile cilia, when they begin to move, at first by a revolving pirouette, afterwards swimming about freely in the water. When one of these larvæ has found a piece of submerged wood, without which it probably could not live, the curious spectacle is observed of a being which fabricates, step by step and as it requires them, the organs necessary for the performance of its functions. It begins by creeping along the surface of the wood by means of the very long tubes with which it is furnished. Then it is observed from time to time to shut the valves of the little embryo shell which partly envelopes it. As soon as it has found a part of the wood sufficiently soft and porous for its purpose, it pauses, attacks the ligneous substance, and soon produces a little depression or opening, which will be the entrance to the future tunnel."

Each hole made by the animal is lined with a calcareous deposit, and the end of the hole where the *Teredo* is working is rounded off hemispherically. I have found that a period of six months' immersion of timber in the river Fitzroy is sufficient not only for the entrance of the *Teredo* but also for doing a considerable amount of damage to any timber structure. I have also noticed that the zone of its operations here is generally from a point midway between high and low water marks downwards to the bottom of the timber. Some authorities state that the animal does not work below the level of the mud at the river bottom, but I have observed piles eaten by the *Teredo* to a depth of 5 feet below the mud-line of the river bottom, although I believe it always enters the timber above mud-level.

The kind most prevalent in the river Fitzroy is the *Teredo gigantea;* it grows to a length of about 30 inches, and about ¾-inch in diameter. The anatomy of the *Teredo* has not yet been fully determined, and there has also been uncertainty about the method of its boring operations. So far the animal appears to have preserved this "trade secret" of its method of penetrating into and tunnelling through the hardest known kinds of timber. The question which has hitherto been left as an undecided one by naturalists is as to whether the *Teredo* actually bores into the timber by the aid of its shells with an auger-like action, or by means of some solvent secreted by it acts on the wood at the end of the tunnel, making it soft and capable of being gouged or scooped out by the shells with which it is provided. Osler says, "It bores by means of its shells, fixing itself by the surface of the foot, which it uses as a sucker, and then rasping the wood with the rough front edges of the shell valves." W. Thompson holds "that it works by means of a solvent secreted from the surface of the animal." Albany Hancock thinks "the excavating power of the *Teredo* is due to siliceous particles embedded in the anterior portion of the integument in front of the valves." This has been denied by others, who discredit the idea of the existence of these silicious particles. Jeffreys believes that "the foot is the organ by which it bores." I have been for some time engaged in observations of the *Teredo* with a view to ascertaining, if possible, the secret of its working, but so far have not been able to settle the point to my complete satisfaction. I intend to continue my observations further, and note the matter in passing, in the hope that some members of the Biology Section of the Association may be able to join in the future investigation of this subject.

THE RAVAGES OF THE TEREDO.

The destructive work of this animal is very frequently under the notice of the shipbuilder and the civil engineer; and from what I have seen of its ravages in different parts of Australia, I consider the economic aspect of the habits of the *Teredo* is one of very great great importance. The destruction of valuable river and harbour works built of timber is very great, and the loss throughout Australia from this cause must amount to a considerable sum of money. As an illustration of this loss through the work of the *Teredo*, I may mention a large timber wharf in Rockhampton—the piles of turpentine timber from New South Wales--built about ten years ago at a cost of over £7,000, and which has been almost entirely destroyed by the *Teredo* in that time. I am informed that the owners of the wharf and their engineer were advised at the time of its construction that the timber used for the piles and other submerged portions of the structure was proof against the *Teredo*, but the result has shown that this timber is, like most others, liable to destruction in the end. It is a curious fact, however, that a few piles, about three out of over 200 piles in all, have so far successfully resisted the animal; but I think this is accounted for by the fact that the bark has not yet been ruptured, as has been the case with the rest of the piles. The whole of the piles in this work were driven with the bark on, and of course some piles would have the bark in a more perfect condition than others.

PROTECTING TIMBER AGAINST THE TEREDO.

Many expedients have been adopted to guard timber work against *Teredo* attacks, but the most of them have hitherto been only partially successful. One expedient is to drive nails with flat and square heads into the timber so closely together as to prevent any access by the animal. The most common method is to sheet the timber with copper or muntz-metal, having overlapping joints laid as closely as possible. These methods are, however, sometimes rendered useless by the metal being torn and the wood exposed; the slightest opening being made, the *Teredo* can attack and destroy the timber as easily as if no sheathing had been applied.

Various other applications have been tried, especially in Holland and the United States of America, where marine and river works are almost universally of timber construction, but with little or no success. In San Francisco the following preventive applications to wooden piles in the harbour works have been experimented upon, namely:—

1. The piles were jacketed with large sewer-pipes, and the space between the pipe and the pile filled in with cement concrete. The result was the piles were not attacked except in places where the pipe had broken.
2. The piles were coated with different kinds of compositions—one a mixture of asphaltum and burlap; others with varieties of marine cement These were applied to different kinds of American timbers, and allowed an exposure under water of a little over five years. The result was that all the piles were destroyed by the *Teredo navalis*, which is prevalent in the harbour of San Francisco.

THE TEREDO AND QUEENSLAND TIMBERS.

Some years ago my attention was drawn to a timber of this locality (Central Queensland), commonly called "swamp mahogany," the *Tristania suaveolens* of the order Myrtaceæ, and which was said by several old residents to be thoroughly proof against the *Teredo*. I had two piles driven of this timber, the bark being left on, but no sheathing applied, and have recently examined them; and the results are as follow, viz.:—

One pile driven four years ago—not attacked yet. One pile driven two and a-half years ago—already partly eaten by the *Teredo*. I think this is a proof that this timber is not ultimately capable of resisting the *Teredo*, although the bark and sap of the timber render it proof against the *Teredo* for a few years. Some authorities, however, in Queensland claim that this timber is capable of resisting the *Teredo* for a period of twenty years, with no other protection than the bark left on.

In the various works carried out by me on the river Fitzroy, Central Queensland, I have also used the following timbers, namely:—Ironbark (*Eucalyptus crebra*); bloodwood (*Eucalyptus corymbosa*); red gum (*Eucalyptus tereticornis*); and spotted gum (*Eucalyptus maculata*, var. *citriodora*). All these timbers have been destroyed by the *Teredo* whenever from any accident the copper with which they had been sheathed became broken or otherwise opened out.

THE TEREDO AND OTHER AUSTRALIAN TIMBERS.

In order, if possible, to collect the experience of this subject throughout Australia, I have applied to authorities in the other colonies, and the following is the account I have received from Victoria:—

"The only timbers used by the Melbourne Harbour Trust for pile work are red gum (*Eucalyptus rostrata*) and ironbark (*Eucalyptus leucoxylon*) from Victoria and New South Wales, and grey or yellow box from Gippsland. At present there are no symptoms of ravages by the *Teredo*, but the timber has only been in the works for about twelve years. There are no means of protection of any kind used for the piles in the Trust's works."

Extract from report by Commissioner Hodgkinson on submerged samples of timber:—

"I beg to submit the following brief remarks with reference to the piles of timber placed for experimental purposes in the water of Hobson's Bay, about seven years ago, and quite recently (1888) taken up for examination:—

"All of them display some indications of attack by *Teredo navalis*, but the jarrah, ironbark, Gippsland red gum, New Zealand totara, and box of East Gippsland have only been bored by the *Teredo* in a few places, through thin sapwood; the penetration of the matured wood having apparently been arrested by the astringent matter therein.

"The piles of blue gum (*Eucalyptus globulus*), ordinary stringybark (*Eucalyptus macrorrhyncha*), head-flowered stringybark, messmate (*Eucalyptus obliqua*), and bastard box (*Eucalyptus polyanthemos*) have been penetrated by the *Teredo* to such depths as to show that the timbers of these kinds of eucalyptus are liable to serious injury from its attacks.

"This remark is also applicable to gumtop ironbark (*Eucalyptus sieberiana*), the pile of which is not only much perforated by the *Teredo*, but is also decayed in parts thereof, and therefore shows that I was justified in my condemnation, about eight years ago, of the use of this kind of eucalyptus for harbour works, when many woodcutters so persistently endeavoured to induce the Trust to accept piles thereof, and so vehemently challenged the accuracy of my opinion relative thereto."

The following is from a South Australian parliamentary report:— "Jarrah makes excellent piles in both salt and fresh water. Some karri piles have stood well in bridge work, but karri (*Eucalyptus diversicolor*) is unsuitable for piles in sea water, being much more subject than jarrah to the attack of the *Teredo*."

I find from the same report that in Western Australia experiments have been tried with karri and jarrah by submerging the timbers in the sea at Fremantle for one year. The result is stated as follows:—"The karri being completely riddled by the *Teredo navalis*, while the jarrah is perfectly sound."

With respect to the apparent immunity of the Western Australian jarrah (*Eucalyptus marginata*) from the attack of the *Teredo*, it is to be noted that this particular test only extended to one year's exposure in the sea; but as I have found some other timbers able to resist the *Teredo* for that length of time which were afterwards destroyed, I think the one year's test of any timber not decisive. Nor do I consider a small number of pieces of any particular timber a sufficient test, as I have found, in a large work consisting of over 200 piles of the same timber, about three piles out of that number had resisted the *Teredo* without any sheathing, whilst all the rest were destroyed.

I find also that some authorities claim that Western Australian jarrah timber is able to resist the *Teredo*, whilst the Victorian and South Australian authorities already quoted state it is successfully attacked by the *Teredo*. On account of this difference of opinion I think the whole question of the qualities of various Australasian timbers for resisting the *Teredo* and other destroyers would be a proper one for further and united investigation, and perhaps a research committee of this Association might undertake the investigation and report on the matter.

TEREDO-RESISTING RIVER WORKS.

I have been endeavouring during the last few years to discover some means of effectually preventing the destructive action of the *Teredo* on the extensive timber works on the river Fitzroy belonging to the Municipal Council of Rockhampton, and have now succeeded in effecting that object by means of a composite construction of hardwood timber and Portland cement concrete which I adopted in a wharf recently erected.

In this case I have had timber piles driven into the river bed at intervals of 5 feet along the front of the intended wharf, and also on the line of the two ends of the wharf returned from the river front to the shore, and built walls of cement concrete enclosing these piles in the centres of the walls. Behind this front row of piles are three other rows, the piles here being at greater intervals in the rows, all driven down into the rock. Timber waling-pieces are bolted to the tops of the piles, reaching from the river front to the piles on the solid ground on shore. These, with longitudinal walings running parallel to the river, also bolted to the pileheads, and with diagonal braces, all form a timber framing behind the wall, which acts as a firm stay to it, and effectually prevents any tendency to slip forward into the river.

The space behind the walls is filled up with earth, and covered in by a hardwood timber decking. On the front of the wall next the river strong fenders of cast iron are inserted, and tied into the concrete work and timber framework. These fenders extend from the top of the wall down to a few feet below low-water mark to receive the chafing of the shipping.

The whole forms a quay wall which is absolutely secure from the attacks of the *Teredo*, as the only surfaces exposed to the water are of cast iron and cement concrete.

The concrete of which the walls are composed was laid partly under low-water level, and for this purpose special bags were designed by Mr. W. Burns, contractor, to allow of the concrete being emptied on the bottom of the river or on the concrete wall when the bag was resting on the bottom. This is a *sine qua non* with subaqueous monolithic concrete work, as distinguished from bag concrete work, on which the concrete is laid in position in the bag. In order to test the efficiency of the bags for depositing the concrete without separating the materials of which it was composed and washing out the cement, which is the result when concrete is allowed to fall even a few inches through water, I carried out a series of experiments, in which I had the concrete tipped under water into wooden cases, which were afterwards drawn up for the examination of the concrete, which was found to be sound and good.

With respect to the union of the concrete with the timber, I may state there is no difficulty on that point. All the piles were barked and the sap also removed, and it has been found on examination of work of this kind, after eighteen months have elapsed, that the concrete adheres most tenaciously to the timber.

After a few years' test of the work in this new wharf, the result is highly satisfactory ; in fact, it forms a permanent structure adapted to river or marine work at a cost not much exceeding that of a timber erection, which is liable to be destroyed in a few years.

6.—SOME NOTES ON THE RIVER FITZROY, CENTRAL QUEENSLAND.

By THOMAS PARKER, C.E., Town Surveyor and Engineer of Waterworks, Rockhampton.

The river Fitzroy is one of the most important of the many rivers on the eastern side of Queensland which flow into the Pacific Ocean, and it drains a large portion of that colony. The large district forming the gathering-ground of its waters extends from the Great Dividing Range on the south to Mount Britten on the north, a distance of about 260 miles, and from the city of Rockhampton on the east to the Drummond Range on the west, a distance of about 190 miles. This river is formed by three principal tributaries—the Dawson River, which drains the southern portion of the catchment area; the Mackenzie River, formed by the junction of the Nogoa and Comet Rivers, and which gathers the waters from the western part; and the Isaacs River (with which is united the Connors River), which flows through the northern part of the drainage area. These three main tributaries unite at a point a little to the north of the township of Boolburra, forming the main stream of the Fitzroy River.

From this point of junction the river takes a very circuitous course on its way to the ocean, forming a bow, the string of which measures about 50 miles in length. It runs first in a north-easterly direction for a considerable distance, on its way passing through a gap in the Boomer Mountains, then turning to the south-west it follows very nearly this direction until it falls into the ocean.

DIMENSIONS AND CATCHMENT AREA.

The length of the river, measured from the source of the Dawson River branch to the outlet at Keppel Bay, is about 520 miles, including bends of the stream. The total length of the river above tidal influence is about 450 miles from its rise to the township of Yaamba, where the tidal influence ends; and from the latter place to the sea, about 70 miles.

The catchment area is about 49,000 square miles, which includes all the country drained by the river above Rockhampton. As a great portion of the gathering-ground of the river is within the Tropics, I expected to find the proportion of the rainfall discharged greater than in the drier countries of Australia, and this I find to be the case.

RAINFALL DISCHARGED IN THE RIVER.

There are, unfortunately, no systematic gaugings of the fresh water flowing in the river above the tidal influence. I have, however, taken gaugings of the water on a few occasions, and these will give an approximate idea of the quantity at the time of my measurements. The first estimate of the discharge of the river made by me was during the great flood of 1890, when I took the velocities of the stream at different periods during the flood and in different positions. I estimated the total quantity of water discharged at Rockhampton during the months of February, March, and part of April at about 1,177,000,000,000 cubic feet. I find the total rainfall over the catchment of the river during March, 1890, was 13·47 inches. This rainfall over the catchment area of 49,000 square miles gives a total quantity of about 1,523,965,000,000 cubic feet. The water discharged by the river during the period in question was about 1,039,000,000,000 cubic feet, or about 60 per cent. of the whole rainfall on the gathering-ground of the river.

The lowest summer flow which I have observed was in 1892, when I took gaugings at the township of Yaamba, and, as this is just above the flow of the tide, it is a favourable position for measuring the volume of the fresh water in the river.

From measurements taken at three stations for observation at Yaamba, I estimated the flow at about 67,000,000 cubic feet, or 420,000,000 gallons in twenty-four hours. Station No. 1 recordea 431,000,000 gallons; Station No. 2 showed 399,000,000, and No. 3 about

432,000,000 gallons. The above result given is the average of the records of the three stations. This quantity flowing in a very dry season, expressed in terms of supply for a city, represents more than the required quantity for a population of over 5,000,000 persons. I also estimated the quantity of fresh water passing down the river during the same month (March, 1892) at about 2,073,000,000 cubic feet. The rainfall for that month over the catchment area averaged 2·14 inches in depth. This makes the total quantity of rainfall during that month about 243,610,000,000 cubic feet. The water discharged in the river during the period in question, therefore, only amounts to about ·85 per cent. of the rainfall, showing that in a dry season nearly the whole of the rainfall percolates into the ground.

Since taking these observations, I notice that a gauge has been fixed on the river at Yaamba by a Government department, but, as it is only intended for navigation records, I am not able to make use of the record of river levels for the purpose of calculating the flow of water in the river over a more lengthened period, which is very desirable.

NATURAL BY-WASH FOR FLOODS

In taking observations during the flood of 1890 I noticed the interesting fact that this river has a natural by-wash about five miles above Rockhampton, where there is a depression in the bank of the river on the south side. When the flood waters in the river rise to that level they overflow through this depression, and the waters run across the country through a chain of lagoons—namely, the Lilymere, the Racecourse Lagoon, and the Crescent Lagoon, from which the water supply of Rockhampton is taken; from this they pass on through the Yeppen and Serpentine Lagoons, and thence over the low-lying alluvial flats of the town common and adjoining country, and onward into the river again, and into Keppel Bay, near the river mouth, at various points; thus during extremely high floods the river forms a loop round the city of Rockhampton, the lower lands of which place only are covered by the flood waters.

One important point I have noted is the portion of water discharged in the ordinary channel of the river and in the natural by-wash. The following are approximate records of the waters flowing in these channels. The flow in the ordinary river channel at Rockhampton during the period of the 1890 flood I estimated as follows:—

	Water Flowing. Cubic Feet.
During rise of river up to 4 feet	137,200,000,000
" " " 12 "	118,000,000,000
" " " 20 " and upwards	384,800,000,000
" falling river	172,000,000,000
Total	812,000,000,000

I estimated the water discharged by the natural by-wash in the following manner:—The approximate section of the flow of this water was taken opposite the Crescent Lagoon, which was as follows—namely, a portion of the stream about 6 chains wide flowing at the rate of two miles per hour; then about 40 chains of slack water; then about 80 chains measured on the line of cross-section, a stream running at an average velocity of about three miles per hour. The average depth over the whole was about 5 feet. The water discharged during the time the river overflowed its banks into this by-wash I estimated to be about 365,000,000,000 cubic feet. This, together with the quantity discharged in the ordinary channel, makes the total quantity of 1,177,000,000,000 cubic feet during the high flood of 1890.

Whilst the river was in high flood and overflowing its channel, I find the quantity of water flowing in a given time in the by-wash behind the city was greater than that in the ordinary channel. The figures are approximately as follow:—

		Cubic Feet per second.
Discharge in river channel at Rockhampton	...	260,000
„ by-wash behind the city	...	272,000
Rate of total discharge during the 1890 flood	...	532,000

COMPARISON WITH THE RIVER MURRAY.

As numerous gaugings of the flow of water in the river Murray have been taken in the various colonies through which it passes, it may be taken as a kind of measure for comparative estimates of river flow in Australia.

The discharge of water in the two rivers is approximately as follows:—

River Murray.

From gaugings at Morgan, South Australia.

	Discharge.	
Low summer level (May, 1884),	2,071 cubic feet per second.	
High flood level (Decr., 1886),	32,000	do.

River Fitzroy.

	Discharge.	
Low summer level (March, 1892),	800 cubic feet per second.	
High flood level (1890),	532,000	do.

It will be seen from these figures that when the river Fitzroy is at its highest flood level it is discharging many times the quantity of the river Murray flood waters. On the other hand, it is to be noted that the discharge in the river Fitzroy at low summer level touches a lower point than that of the river Murray.

QUALITY OF THE WATER.

In order to test the quality of the water in view of the possibility of using it as a source of supply for the city of Rockhampton, I have taken observations and had analyses made of the water within the tidal influence below Yaamba, and beyond the tidal influence above that place. The following are analyses of samples of water from the river during a dry season and outside of the tidal influence :—

	At Yaamba.	From Alligator Creek.
Organic matter ...	trace ...	trace
Total fixed salts ...	28·70 ...	29·60
Hardness	15·00 ...	16·00
Chlorine	4·20 ...	4·90
Nitric acid	none ...	none
Sulphuric acid ...	none ...	none
Ammonia	trace ...	trace
Albuminoid ammonia	trace ...	trace

In order to test the feasibility of taking a water supply from the river Fitzroy within the tidal influence near Rockhampton, I have taken observations of the saline matters in the water, the observations being extended over a period of over twelve months. The results are shown in the following statement :—

STATEMENT OF OBSERVATIONS OF THE WATER IN THE RIVER FITZROY, ROCKHAMPTON.

1892.	Oz. of Salts per Gallon.
July 7 to 29	From $\frac{2}{8}$ to $\frac{3}{8}$
July 29 to August 1	Water fresh
August 2 to 30	From $\frac{5}{8}$ to $\frac{6}{8}$
September 1 to 30	From $\frac{11}{16}$ to $1\frac{1}{4}$
October 1 to 26	From 1 to 2
October 27 to 31	From 2 to $\frac{1}{2}$
November 1 to 30	From $\frac{3}{8}$ to $\frac{1}{8}$
December 1 to 31	$\frac{1}{4}$ to $\frac{1}{16}$
1893.	
January 2 to 20	From $\frac{1}{16}$ to 0
January 20 to February 28	Water fresh
March 1 to 9	0 to $\frac{1}{16}$ (nearly fresh)
March 10 to 29	Water fresh
March 30 to April 20	From $\frac{1}{8}$ to $\frac{1}{4}$
April 21 to May 18	From $\frac{1}{4}$ to $\frac{1}{16}$
May 19 to 30	Water fresh
June 1 to July 31	From $\frac{1}{16}$ to $\frac{3}{16}$
August 1 to 7	From $\frac{1}{4}$ to $\frac{1}{16}$
August 7 to 11	Water fresh
August 11 to 16	From $\frac{1}{4}$ to $\frac{1}{16}$.

It will be seen that the water of the river within the influence of the tide contains salts in large quantities, as might be expected; in fact, the quantity of salt is so large as to make it impracticable to take a supply from it for domestic use. It had been alleged by observers that the fresh water flowing down the river passed over the surface of the salt water coming up with the flow of the tide without much intermixture, and in order to test this theory I had the samples taken daily from near the surface of the river for examination by the salinometer. In addition to the saline matters in the water, the fact that a considerable quantity of town sewage is poured into the river constantly, and by the flow of the tide could be carried within reach of any pumping machinery placed within tidal influence, makes it very undesirable to take water from the river at this part for a town supply or at any point within the flow of the tide.

GAUGINGS SUGGESTED.

I need scarcely point out the great value of something like accurate gaugings of the quantity of fresh water flowing in a stream of such importance as the river Fitzroy, and it is especially desirable, when these gaugings are to be used as data for calculations for engineering works, that they should be the results of measurements extended over a lengthened period. When at a future time there come up for consideration schemes for taking water from the river for the supply of towns and for irrigation of the contiguous lands, or when the canalisation of the stream or other similar river improvements are to be considered or designed, such observations as the gauging of the flow of water will be a necessity. I would suggest that in addition to the levels of the river at Yaamba, which are now taken for navigation purposes only, there might be further records made at regular intervals of the velocity of the water and other data necessary for calculating the flow of water in the river.

7.—EARTHQUAKES, WITH THEIR INFLUENCE IN BUILDING CONSTRUCTION.

By THOS. TURNBULL, F.R.I.B.A.

In the Third Annual Report of this Association Mr. Hogben, of Timaru, has a paper on, and a list of, 775 earthquakes that have been felt in New Zealand between the years 1848 and 1890. These, though numerous, have been on the whole of a mild character, and the loss or injury sustained from earthquake effects not of a very serious nature. Their frequency, however, has kept us awake to the danger of carelessness in the construction of our buildings, but this may be considered more beneficial than otherwise. Not that I admit the number; though Mr. Hogben is not satisfied, says his list is incomplete, and thinks that with care he could materially add to the account. Now, our early settlers had no want of physical courage, as they have shown on many occasions; but as they had had no experience of earthquake phenomena the dangers were greatly exaggerated. They set themselves to study the subject, and as a result we have seismographs everywhere, and whether they are affected by earth, air, railway trains, or coal wagons, all these shocks are recorded as earthquakes, and the number is unduly swollen.

Following the lead of Mr. Hogben, and wishing in some way to further the objects of the Association, I have compiled this paper on earthquakes and building construction for your consideration, hoping it will be of some interest to the members. No doubt Australia has hitherto been almost free from earthquakes, and on that account the phenomena may not have had the attention they receive where these disturbances occur. Still the time may come when they may leave New Zealand and pay you a passing visit. For, according to the great geologist, "The energy of subterranean movements has always been uniform as regards the whole earth, and that the force of earthquakes may for a cycle of years have been invariably confined, as it is now, to large but determinate spaces. Gradually, however, this force shifts its position, so that other regions for ages at rest become in their turn the grand theatre of action." But though violent earthquakes are confined to limited regions, complete quiescence is nowhere to be found. Professor Milne finds the soil of Japan in a constant state of vibration. It is the same in Italy. So much is this the case there that many of the towns now have building regulations providing for their security. Even the soil of Britain is never absolutely at rest. So this subject should have interest for mankind everywhere.

I do not propose to read you an elaborate essay on earthquake phenomena, but will confine myself to such as may, in my opinion, have led to our modern so-called earthquake-proof construction.

Earthquake phenomena have been divided into three kinds—namely, the explosive, the horizontally progressive, and the verticose.

The first is described by Humboldt, and has a violent motion directly upward, like the explosion of a mine, by which the crust of the earth is broken up, and bodies on the surface are thrown into the air. The best example of this is the great earthquake of Riobamba, which occurred in 1797. In this case the nature of the shock was precisely as if a fearful explosion had taken place immediately beneath the fated town. The earth was not only broken up and fissured in many places, but, what was most characteristic, bodies lying on the surface, among which were bodies of men, were actually thrown upward 200 feet in the air, and were afterwards found on the top of a hill on the other side of the river.

The velocity due to this height of projection has been estimated at 80 feet per second, and Mallet thought that it was probably the greatest velocity recorded, or perhaps at present possible, on our earth; and is, as he has calculated, 5·33 times greater than the velocity of the Neapolitan earthquake of 1857, regarding which his great work is written. We may well despair of constructing anything capable of resisting such a shock.

Le Conte is of opinion that the horizontally progressive earthquake must be regarded as the true type, and describes it in this way:—"A concussion occurs deep beneath the surface—a succession of spherical earth-waves emerges first immediately over the focus. From this point a series of rapidly enlarging spheres or shells radiate. If the elasticity of the earth and the velocity of the waves are equal in all directions, the surface waves or shells will spread in concentric circles; but if the elasticity of the earth and the velocity of the waves are greater in one direction than another, their form will be elliptical. It is easy to suppose that the shock will be most severe immediately over the point where the concussion occurs, or, as it has been termed, the seismic vertical. The waves here will emerge at steep angles, with a vibratory up-and-down motion dangerous to the stability of buildings. As the waves recede from this point, the angle of emergence will become gradually less until the tremors die away. Unless it may be over the focus, the danger to buildings in this case will be much less than in the explosive."

In the case of verticose earthquakes the earth is whirled round and back in something like the motion describing the figure 8. The most conspicuous example of this kind was the great Calabrian earthquake of 1783. In it the blocks of stone forming obelisks were twisted one above another. The earth was broken and twisted, so that straight rows of trees were left as interrupted zigzags. This kind of motion was observed, too, in the earthquake of Riobamba already referred to, and also in a mild way in the Californian earthquake of 1868.

In order that the buildings to be erected in regions where earthquakes occur, whether for public or private use, may be steadfast, suitable for their purpose, and such that the occupants may have a positive feeling of security—notwithstanding any movement (which is inevitable) that the buildings may have while under earthquake influence—to the people of these disturbed regions must ever be an important problem. By continuing the investigation we may hope to arrive at a solution in the discovery of a mode of construction to at least secure perfect safety from the effects of these so-called horizontally progressive earthquakes. Happily for mankind, the explosive and verticose examples are of rare occurrence.

It has always been recognised that to secure steadfastness the foundation of a building plays an important part. Thus Vitruvius says:—"If ground be loose or marshy, the place must be excavated, cleared, and piles must be driven with a machine as close to each other as possible, and the intervals between the piles filled with charcoal." This, he says, will carry the heaviest foundation. I cannot find that he used any precautions against earthquakes.

Pliny implies that the Greeks studied the effects of earthquakes upon buildings. Thus in his description of the Temple of Diana, at Ephesus, he tells us that a marshy soil was selected for its site, in order that it might not suffer from earthquakes or the chasms which they produce; and that the foundation of so vast a pile might not have to rest upon a loose shifting bed, layers of trodden charcoal were first placed as a foundation, and fleeces covered with wool were then laid upon the top of them.

This looks like a reliable account, but scarcely agrees with Woods in his work on "The Discoverer at Ephesus." He, having Pliny's description in view, and to test the accuracy, caused holes to be sunk in different places, and found a layer four inches thick, and below that another layer of putty-like composition. This, when analysed, was found to consist of carbonate of lime, 65·91; silica, 26·10; water, &c. (volatile), and a trace of nitrogen, 7·99; so that, in fact, there was nothing but a species of mortar.

In Pliny's chapter, under the head of "Preservation against Earthquakes," he says:—"Where there is a number of caverns they afford a protection, as they give vent to confined vapours, which has been proved in certain towns which have been less shaken when they have been excavated by many sewers, and in the same town those parts that are excavated are safer than the other parts, as is understood to be the case in Naples, the part of it which is solid being more liable to injury." He also tells us that "the capitol of Rome was saved by the catacombs." Elise Reclus has it that "both Romans and Hellenes believed that wells and quarries retarded the disturbances of the earth, and were a protection to buildings in their neighbourhood." Humboldt relates that the inhabitants of San Domingo sink wells in order to weaken the effects of earthquakes; and Professor Milne has it that "Quito receives protection from the numerous cañons in the neighbourhood, whilst Lactacinga, fifteen miles distant, has often been destroyed," and similarly, he thinks, "it is extremely probable that many portions of Tokio have from time to time been protected more or less from the severe shocks of earthquakes by the numerous moats and deep canals which intersect it." In addition to the foregoing, many of our modern inquirers believe that deep foundations are a great preservative from the effects of earthquakes, but the security here sought for will greatly depend on the distance from the seismic focus and the nature of the substratum.

Dr. H. J. Johnston-Lewis, when reviewing the effects of the earthquake in Ischia in 1883, found that "houses built on the sea land suffered very much less than neighbouring ones built on alluvial and therefore loose incoherent tufa; and these latter again suffered much less than those built on the comparatively hard tufa rock of the island. The maximum damage occurred on or in the neighbourhood of the masses of highly elastic trachyte."

In reference to Casamicciola, he continues:—"We have a striking example of the effects of geological structure in modifying earthquake violence, for here we see how the looser the particles of a rock are, on which buildings rested, the less they have suffered. Were it not for tidal waves it appears that it would be preferable to build on the seashore, where they would have a foundation of sand." From all the facts he concludes that "buildings should be placed on nearly level ground, and at a distance from any declivity or cliff edge." Individually, he prefers the principle of fixing the buildings firmly to the ground, and communicating the earth's movement to the whole simultaneously.

Professor Milne, writing of foundations, remarks that "one suggestion is to place a building upon iron balls." Another method he suggests is "to place a building on two sets of rollers—one set resting on the other set at right angles. The Japanese themselves build their houses on round stones." The professor is of opinion that "one of the safest houses for an earthquake country would probably be a one-storied, strongly framed wooden house, with a light flattish roof made of shingles or sheet iron, the whole resting on a quantity of small iron balls."

Dr. Johnston-Lewis, when writing on the system of supporting buildings on iron balls or similar mechanical arrangements such as those adopted by Professor Milne in Japan, objects to them because of their great cost, and the difficulty attending this mode of construction, and thinks he is right in adding the comparative uncertainty of action, combined with the fact that it affords protection from undulatory motions only. He says:—"Of course it might be possible to introduce a kind of spiral spring mattress above the balls to absorb vertical motion, but with such arrangements a dwelling-house would represent a great and costly seismograph."

With respect to the security of foundations, Professor Milne has endeavoured to show by experiments how earthquake action may be partially avoided, either by making a seismic survey of the area on which it is intended to build, and selecting a site where the motion is comparatively small, or by adopting *free foundations*. But can we be sure that a spot not much shaken by one earthquake will be as mildly treated by another? There is this also to be considered: That where ground is cheap and plentiful, the selection of a site is never difficult, but in great towns or seaports, where business has centred in restricted localities, and the ground is required, we pay from £100 to probably £1,000 per front foot, and this regardless of the substratum. The problem to be solved is—how to erect a structure on any ground capable of withstanding the shock of an earthquake, such as I have described, and suitable for any purpose for which it may be built. I may shortly note here that the system of iron balls in the foundations to secure the safety of the superstructure might for a light isolated building be of some use, but for large structures much material and excellent workmanship will be required to make this plan effectual. For instance, there is the floor whereon the balls and whole weight of the building with all its contents are to rest. Over this and under every part of the building there must be a strong frame to which the cups to receive the balls are to be attached. All this would increase the cost enormously, besides which, as Dr. Johnston-Lewis points out, there is the "special uncertainty of action" to be encountered if in a city crowded with buildings.

It appears to me that this paper would not be complete as an introductory document unless some brief but particular notice were taken of the Neapolitan earthquake of December, 1857, not only that it is classed as the third greatest in extent and severity of which there is any record in Europe, but because Robert Mallet, who had already distinguished himself in cosmic science, here applied those principles to Nature which he had already enunciated, and was afforded an opportunity of the highest interest and value for the study of this branch of terrestrial physics. He wrote to the Royal Society of London offering his services, which were promptly accepted, and he was requested to proceed to Naples and make an investigation.

He explains that his observations were to have reference to two distinct orders of seismic inquiry—"By the first to seek to obtain information as to the depth beneath the surface of our earth at which these forces (whether volcanic or otherwise) are in action, whose throbbings are made known to us by the earthquake, and thus to make one great and reliable step towards the knowledge of the nature of these forces themselves." By the second "to determine the modifying and moulding power of earthquakes upon the surface of our world as we now find it; to trace its effects, and estimate its power and extent upon man's habitation and upon himself." And these are the branches of seismology most important to architects.

Let us briefly state how he succeeded in these objects.

For the first order of inquiry he found a splendid field. He remarks that, "in the chain of buildings for arriving at the angle of emergence from subnormal fixtures, those must be selected that are of larger size, with walls of brick, or of rubble masonry of inferior quality, or at least of small, short bonded stones, in proportion to the size of the walls, and, fortunately for seismic inquiry, there is no want of such in the south of Italy"; and, again, "Fissures in walls not overthrown are the sheet anchor, as respects direction of the wave path, to the seismologist in the field." Taking these for data, he made the calculation for the first approximation to the depth of the focus ever attempted for any earthquake. He was at the same time, able to measure for the first time the velocity of transit, and the velocity of the wave particle at its maximum. He might well be pardoned for displaying some elation on announcing these facts. "Geologists," he says, "must not be surprised to find that they differ enormously from each other, that the velocity of transit is about half that of a cannon shot; but the velocity of the wave particles which does the mischief is not as great as that with which a man reaches the ground when he jumps off a table, and yet that this small velocity is competent to produce all the violent and formidable effects of earthquakes no longer admits a doubt."

As to his second order of inquiry—and to architects the most interesting—he has by implication shown us what material to avoid and what is suitable; he has also shown how, with good workmanship, our buildings may be rendered capable of withstanding an earthquake of as great severity as that of which he writes. For instance, he says: "There is no cause for wonder at the great destruction, the wonder is there was not more," and thus describes Italian architecture: "The usually grandiose effect of their buildings generally conceals workmanship of a very inferior quality. The floors of the better sort of town houses are formed of joists of fir, commonly round as they grew, and from 6 to 9 inches in diameter, placed about 3 feet apart, the ends inserted a few inches into the wall, but neither bedded on nor connected by any tossils or bond timbers, none of which are ever placed in the walls. On these joists a planking of fir, oak, or chestnut, an inch or an inch and a-half thick, rough from the saw is laid, and upon it a bed of concrete or beton composed of lime, mortar, broken tufa, brick, or stone, is next laid, with red tiles on top, or sometimes plastered over with mortar, and painted in oil. A floor of this sort weighs from 60 to 100 lb. per superficial foot, the roofs being more primitive and weighty."

The chief difference in point of masonry from those in country towns is that surface limestone or exposed beds of rocks are commonly used. Hence the walls built almost invariably of this coarse, "nobbly" rubble, in half-round blocks, or of lumps of stone, in form like irregular loaves of bread, are almost devoid of bond, and are shaken down into a heap by forces that would only fissure a well-built and properly bonded structure. It is upon these heavy floors and roofs, with the defective masonry described, that the most instant and formidable effects are produced by vertical emergence. Upon these the velocity produces a moment of inertia, acting directly downwards, and therefore favoured by gravity, arched roofs, joining, and that form of arched ceiling constructed of hollow pottery. I am not aware of the ultimate flexibility or elasticity of stone in brickwork, but Mallet is of opinion that both are small, even in work of the highest quality, but prefers brickwork, as it possesses an extent of flexibility in a far higher degree than the masonry, the bond of the mortar being better, the flexibility greater, both in the bricks and numerous mortar joints, and the elasticity more nearly alike in both, and this is just the fundamental reason that in all countries subject to earthquakes brickwork has been preferred to stone in all times.

Let us now turn to a region where, fifty years ago, the churches, law courts, convents, the residences of the territorial magnates, as well as the dwellings of the workers, were all built of unburned brick, dried in the sun, and all roofed with clumsy red tiles, and where the people in possession would have been content to let this state of things go on for ever. By the fortune of war and by its cession to the United States all this was soon changed, and it has now become the most progressive country the world has yet seen. Soon its mineral wealth was discovered, and California became celebrated, and immense multitudes were attracted to its shores. Buildings for their accommodation were rushed up in all directions, but chiefly in Sacramento and San Francisco, many of them in wood and a few in brick. At that time building speculators knew nothing about earthquakes, and cared less, so they tacked their structures together in the cheapest and easiest manner possible. In those days they were a law unto themselves. For all this, numbers of these erections stood for many years, one of them (the Webber House) as late as 1868, when it was destroyed. Some of them may even be standing at this day.

When the novelty of settlement in the new country had somewhat abated the new settlers began to realise that the ground under their feet was of anything but a stable character, that now and again their habitations were shaken up in a very unpleasant if not dangerous manner. They felt that the methods of construction they had hitherto practised were unsuitable for their new home, and must be changed. But it was not until the morning of the 21st October, 1868, that the danger was fully realised. Then occurred the severest earthquake the diggers of that region had ever felt, and for a few hours caused great excitement, particularly in San Francisco. However, after careful surveys had been made, it was found that the injuries sustained were not so many nor so severe as might have been expected, considering the way in which the city had literally been run up. Before noon the inhabitants had recovered their energy, and mechanics in the building trades became in great request. The incident was treated as one to be prepared for in the future; there was no despondency anywhere. What a contrast this to the inhabitants of the Italian towns under similar circumstances!

After this date the Institute of Architects and other kindred institutions in California bestirred themselves, and methods for improving the old systems of construction were discussed, so that buildings in future might be in large measure proof against earthquake shocks. The following are some of the results of their deliberations:—

In San Francisco, the great part of what is called the city front, probably 750 acres in extent, has been reclaimed from the Bay, the material for filling having been cropped from the sand downs on the higher sections. It is on this made ground that most of the great importers and wholesale merchants have their establishments, and where the foundations of the buildings require the greatest care. There are two methods of forming foundations on this area, and both so far have proved effective.

First, where the subsoil is known to be uneven, and consequently the filling of unequal depth, piles are driven until the solid ground is reached. After they have all been driven, the heads are cut off below high-water mark. Beams are then laid on them of sufficient width to take in the whole thickness of the walls of the superstructure. These beams are piped down on the piles with iron straps and bolts, and the beams themselves are bolted and strapped together at the angles, and held together immediately with bolts at short intervals.

The second system, which is termed a *floating foundation*, is of course used when the subsoil is known to be comparatively level and the filling of nearly equal depth. The ground is first cleared down to about two feet below high-water mark. A double layer of thick planking is then laid in reverse angles to each other, and on this planking beams are laid broad enough to embrace the full thickness of the walls. The planking and beams are then firmly bolted together. This system is, I think, what Professor Milne has named *free foundations*.

In the upper parts of the city there is no difficulty in getting good floors to build upon. Sound clay beds extend over a large area, and, where the sandhills have been levelled, there are good sandbeds which make admirable floors to build upon if kept from spreading. Wherever the buildings, and on whatever material they rest, it is at the foundations they must be held together.

In seeking to accomplish this, there were some who preferred the floating foundations to piles on the made ground. Mistakes were liable to occur through carelessness or miscalculation—one part of the foundation settling more under the load than another, cracks and rents being the result. In spite of these considerations there were many buildings erected on foundations constructed on this principle that stood the test of time. In contradistinction to this it was urged that in a pile foundation there are none of these difficulties if the piles are driven down to absolute stoppage, so that the settlement under the weight of the structure is wholly impossible; but then the centre of motion instead of being at the sill of the buildings is at the foot of the piles, and the blow from the motion of the earthquake is communicated direct to the building, and therefore affects it more severely than a building on a floating foundation. The made ground under the building, acting as a cushion, deadens the blow.

There are several systems of construction practised for the superstructure. One is to erect a wooden frame strong enough to support the floors and roof; the exterior being built of sound brick masonry, having hoop-iron well tarred laid in longitudinally for every 30 or 36 inches in height, heavy bond-iron girting the building at floors and roof to support the timbers, iron anchors from the outside of walls firmly fastened to the flooring joists, ceiling joists, and rafters to bind the brickwork to the frame. A more expensive plan is to girt the building at the foundations, floor, and roof with bond iron, having vertical rods at pillars and angles; these were supplemented with angle rods bolted to them where practicable, the walls being built of brick to satisfy the underwriters. It was calculated that a building erected on this principle, and being an arrangement of triangles, would have strains of extension that would safely bear 20,000 lb. per square inch, and that the walls, if of good brick masonry, would stand safely 30,000 lb. per square foot of this kind of strain.

Previous to 1868 it had been a general custom to make use of cast-iron for the first story fronts of business premises. Now, there were sometimes cases where the cost of a building was not the first consideration. In these the use of cast iron was to be carried a little further. There was no doubt of its fitness, as in no instance had a cast-iron column or lintel been broken by an earthquake. The bearings and supports throughout the buildings were made wholly of this material. Brickwork was used in such a manner that, although the brick formed the bulk of the walls, the dependence or support was entirely with the iron; the brick forming the muscles of the structures, so to speak, and the iron the articulation. Iron girders and joists were introduced to support the floors, so as to render them, in some measure, proof against earthquakes, and also against fires. The cost of this system prevented its use, and few examples were built.

A simpler system than any of these is now practised. The walls are built of brick, bedded in cement mortar tempered with lime so as to slow the setting, and also to bring it as nearly as possible to the consistency of the brick when set. The buildings are girt at the foundations, floor, and roof with bond iron. These are complemented with the usual adjunct of hoop iron built in the brickwork. The flooring joists are broad and of more than the usual thickness, and carefully budged so as to be capable of resisting lateral thrust. The ends of the joists at intervals of five or six feet have anchors with cross-heads firmly attached to them, and these run through the walls. The same precautions are applied to the roofing timbers. It will be seen that these buildings mainly depend on the adhesiveness of the brickwork, which if properly executed will resist an enormous force.

Brick chimneys are a fruitful source of danger in wooden buildings, and in this earthquake of 1868 the fact was well illustrated. There were whole rows of wooden buildings to be seen with the chimney-stacks chopped off at their juncture with the roofs, only proving what was known before—that the two materials having different periods of vibration, injury at their connection was sure to follow if not provided for in some adequate way. The stability of buildings is mainly due to a combination of strength and elasticity, and they must be constructed so that when a shock occurs they may vibrate as one whole. Having these considerations in view, and to ensure greater security in case of future disturbances, an iron tube the size of the flue is sometimes set up, and outside that another 4 inches larger; the space between is then filled up with plaster of Paris, and from where the stack leaves the roof a moulded top of galvanised iron of any preferred form is fixed. Another method is to enclose the inner tube with brickwork and finish the exterior as usual. In the latter case the tube is formed with a thicker plate of iron. Both methods appear to fulfil the requirement.

From California, let us return again to Italy, and hear what Dr. Johnston-Lewis has to say on the construction of buildings for Ischia after the earthquakes of 1881 and 1883:—

"The destruction produced on buildings is due to their incapacity to follow the earthquake movements. Their great weight as ordinarily built in Ischia gives them enormous inertia, so that it is some time before the earth's movements can be communicated to them; and as a result, when the foundation is carried forward by the earth, the upper part lags behind. When the earth returns the upper part has commenced to move forward, but the foundation is going backward, so that the walls are fissured and broken by the strain between their free and their fixed portions or foundations, often crumbling to pieces, since their elasticity and the cohesion of their constituent parts are almost *nil* compared with their weight. We therefore see," he says, "that for buildings to withstand principally undulatory movements two methods may be adopted—the first to make them stronger, so that they may be able to resist such movements, or they may be isolated in some way from the ground."

If resort be had to tiebars they should form a complete framework to all the walls and floors which from their quadrangular form require breaking up into triangles by diagonal bars from one corner to another. The objections to mixing iron bars and masonry are twofold: first, the diagonal bars from the lower corner of a wall on one side to the upper one opposite would require a special arrangement of doors and windows so as not to interfere with them, a difficulty which all architects will but too fully realise. Secondly, the continual strain produced by change of temperature in causing contraction and expansion of the iron bars running in different directions, although slow, would be a sure agent in the gradual disintegration of the masonry. There is no doubt possible that a moderately secure house might be made by combining masonry with a network of tiebars or girders in the walls and floors, so that they could resist both subsultory and undulatory shocks. Another principle that could be adopted with greater success is to employ materials with the minimum of inertia and the maximum of adhesion and elasticity. Such material is to be had in wood and iron.

He concludes that for Ischia, the locality under consideration, it will be found convenient to construct houses of iron and wood, the latter being used for lining. For the floor a solid framework of iron or wood, with a judicious introduction of hollow tiles and good concrete, would be justifiable. The floors, and in some rooms even the walls, might be covered by thin French tiles; in fact, if the houses are designed in a proper manner they may be made more hygienic, more commodious, and pleasanter than those of masonry.

We have seen that the main cause of destruction in the houses is due to the earth's movements being communicated to the upper parts too late, and after the foundations have commenced to move. This weakness might be overcome by using strong tiebars attached to the iron framework.

Having now, as far as I am able, explained the different methods or so-called earthquake-proof construction in regions where earthquakes are prevalent, permit me to add a few words before I close this paper.

In 1850, Robert Mallet, with his son, completed a catalogue of earthquakes for the British Association. Beginning at the earliest accepted chronological time, or 2,000 years before the Christian era, they continued on until 1850, thus comprising a period of 3,850 years.

There are recorded nearly 7,000 separate earthquakes on land or at sea, which have affected almost every known part of the globe. It was about the time of the completion of this catalogue, or perhaps a few years earlier, that Robert Mallet and a few other savants began to study seismology, which in a short time became a favourite and an established science. So well has it prospered, and so extensively, that there are seismologists in every civilised and half-civilised corner of the globe, and in close proximity are to be found the telegraph wires with operators in attendance. In consequence, not a shake of the earth's crust takes place, but through these wires information is flashed in a few minutes to the uttermost part of the earth.

As a result, since 1850, a catalogue of earthquakes might be compiled far exceeding in number that of Mallet's, and with all the completeness of data he could have desired. This immediate increase in such a short time is solely due to the wider field, the closer observation, and the excellence of the instruments, for there is not the least reason to suppose that earthquakes have become more frequent than they ever were. It is only the earth and its manifestations that are becoming better known. For instance, this better knowledge which I have tried to show you has drawn the attention of engineers and architects to the necessity of discovering or inventing methods of building construction, so that the people living in regions where disturbances occur may have a feeling of safety when within their habitations. This may seem a hopeless task to achieve, when in the case of such eruptions the impelling forces appear omnipotent, but let us hope that this prodigious power will be as rarely exemplified in the future as it has been in the past. As to the ordinary progressive earth movement, there is, in my opinion, a sure hope that the difficulties in the way will be surmounted, and that absolute safety within our dwellings may yet be secured.

8.—COMBINED AND SEPARATE SYSTEMS OF SEWERAGE.

By JOHN ROGERS, Assoc. Mem. Inst. C.E.

In the designing of sewerage works for cities or towns, the economical carriage of sewage is a matter of considerable importance, seeing that it affects both the health of the citizens and also the extent of capital cost, the latter including redemption and interest which have to be provided by the ratepayers by payment of rates.

Taking up the question from a hygienic standpoint, it is desirable to admit a portion, if not the whole, of the rainfall falling within the district to be sewered for the purpose of affording a natural flush and cleansing of the drains, more particularly in flat districts, where little available fall is obtained for the drains, and self-cleansing velocities of discharge of the sewage are not secured. In such cases the admission of rain-water would very materially assist in cleansing and purifying the sewers throughout the district. The sewage flowing through drains on flat gradients is necessarily of a minimum velocity, and consequently they become coated with the particles of sewage in suspension, the result being that the sewers become charged with sewer gas generated by the decomposition of the slimy sewage adhering to the drains, which the best system of ventilation would not overcome, and the natural sequence would be the spread of disease and the prevailing nuisance from escaping sewer gas. It is therefore of the utmost importance that sewers of this description should be systematically flushed for cleansing and purifying purposes to as great an extent as possible without resorting to artificial arrangements. With this object in view, it is advisable to admit the rainfall which, by increasing the volume of sewage, and consequently the increased velocity of discharge, would have the desired effect of cleansing the drains.

The additional cost of admitting the rainfall to the sewers in tropical and semi-tropical countries is a question of considerable importance, seeing that the excessive quantity of storm-water to be provided for would mean the construction of sewers of very large capacity, and so much out of proportion to the ordinary work of the sewers during periods of dry weather that a sufficient velocity of current would not be maintained to keep them clean, and consequently they would become immense cesspools of almost stagnant sewage, which by decomposition and generating sewage gas would prove highly injurious to the health of the citizens.

A rainfall 2 inches in depth over one acre is equal in volume to 7,260 cubic feet, and it is not unusual for the rate of fall to exceed $\frac{1}{100}$-inch per minute. If this data be adopted, then the rate of flow to the outfall would be $\frac{3630}{100} = 36{\cdot}3$ cubic feet per minute from each acre.

Taking the population at an estimate of 200 per acre, and the consumption of water at 6 cubic feet per day, the volume of sewage would then be 1,200 cubic feet, 8 per cent. of which would be discharged per hour during the period of maximum flow, or at the rate of 1·6 gallons per minute.

As a 2-inch rainfall, at the rate of fall of $\frac{1}{100}$-inch per minute, gives a volume of 72·60 cubic feet per minute, or forty-five times the volume of the sewage proper, it may safely be inferred that the additional cost attendant on the construction of sewers to provide for the discharge of rainfall would be exorbitant and could not be contemplated.

The additional cost of sewers is, however, not the only extra cost; as, where the sewage has to be lifted by artificial means, the additional cost of machinery for pumping would be very heavy. The difficulty attending proper treatment of the liquid at the sewage disposal works would be considerably augmented, seeing that a much larger volume of water would require to be provided for, and the sudden influx of such largely increased volumes of liquid would have a tendency to throw entirely out of gear all the machinery in operation for the treatment of the sewage.

By the adoption of the "separate system" of sewerage, or separate drains for the sewage proper and the rainfall, the drainage of a district can be carried out on the best and most economical basis. The drains for the sewage proper could be reduced to a minimum consistent to efficient working, provision being made for future increase of population. The drains being small compared with those required for a combined system of sewerage, a greater velocity could be obtained, and the sewers would be practically self-cleansing; and by the adoption of an efficient system of automatic flushing, the sewers would be kept free from all decomposed sewage, thereby in a great measure preventing the generation of sewer gas, the escape of which is a very serious nuisance and the cause of much sickness. The large sewers required under the combined system of sewerage are frequently turned into immense sewer-gas retainers, and, in the event of a sudden influx of large volumes of storm-water, permit the sewer gas to be displaced and to escape through the syphons, traps, and water-closets into the dwellings of the citizens. Under the separate system of sewerage this result is avoided by the rigorous exclusion of all rain-water. Again, in districts where the sewage is raised by pumping, the necessary machinery only for lifting the daily volume of sewage would be needed, and provision would not be made to lift the volume of storm-water, provision for such a contingency being necessary under a combined system of sewerage.

The treatment of the sewage at the sewage disposal works would also be more economically carried out under the separate system, whether the treatment be one of irrigation or of chemical treatment. In either case if rainfall is admitted to the sewers the cost of treatment of large volumes of polluted rain-water would be much more costly, and the difficulty of effectual treatment would be augmented. In the case of the sewage being treated on sewage farms, the manurial properties of the sewage would be considerably reduced, and owing to the large volumes of sewage the effluent would not be of a satisfactory condition.

The drains for discharge of storm-water falling within the district to be drained would be connected to the river or seaside, as the case may be, and the drains being laid with good gradients would discharge the storm-water with greater velocity, and consequently with smaller size of drain than would be the case if a combined system of sewerage were adopted with flat gradients, and the sewage disposal works some miles outside the drainage area.

It has been contended by some writers that the dual system of drains required by private houses for the discharge of the sewage proper and the rain-water would be very expensive and a burden on the ratepayers; but the rain-water drains might be connected to the street water-channelling, the water flowing down these and discharging into the storm-water drains by means of the street gullies. This system could in many instances be adopted with little additional cost to the householders beyond the cost of the sewage drain, and what the ratepayers paid for their own drain connections would be more than compensated for by the gain to the ratepayers in having the sewerage system carried out economically and effectually.

The following general conclusion may fairly be arrived at: That where a town is situated upon a river or stream, or near the sea-coast, the drainage of the town would be more effectually and economically sewered under the separate system than under the combined system, when the exigencies of the particular case demand that the sewage should require special treatment, and where it is desirable that the river or stream should be kept free from pollution.

9.—DOMESTIC ARCHITECTURE IN SEMI-TROPICAL CLIMATES.

By G. H. M. ADDISON.

10.—ARTESIAN WATER SUPPLY AND BORING.

By W. G. COX, C.E.

11.—DESCRIPTIVE ARCHITECTURE AND ART.

By LESLIE G. CORRIE, F.Q.I.A.

Section I.

SANITARY SCIENCE AND HYGIENE.

1.—IS LEPROSY A TELLURIC DISEASE?

By J. ASHBURTON THOMPSON, M.D., D.P.H., Fellow of the British Institute of Public Health, Examiner in Hygiene at the University of Sydney, N.S.W.

ARGUMENT.

I. Heredity an inappreciable factor in lepriasis. *Maintenance* of lepra independent of heredity. The contagion hypothesis. Hirsch's critique thereof still holds. True significance of the discovery that lepra is a bacillary disease. Occasional direct communication of lepra by the sick cannot be formally denied, but direct communication not the means of *maintenance*. Illustrations. General critique of evidence usually adduced to prove the contrary.

II. Long-continued intimate contact with lepers often suffered with impunity: lepra often contracted when there has been no conscious contact with any leper. Inference, that lepra may be easily contracted under favourable circumstances, among which presence of an actual leper not essential. Reply to indirect objections to this argument:—(*a*) Insignificance of a prolonged latent period when communicability is examined by epidemiological methods; (*b*) hypothesis of indirect communicability not supported by ascertained facts. Importation of lepers does not give rise to new areas of endemicity. General critique of assertions to the contrary. Their crucial importance: if well-founded, the *maintenance* of lepra by communication with lepers would be established beyond dispute. Their want of foundation in ascertained fact. Illustrations. Negation.

III. Of comparative susceptibility. The physiology of defence. Poverty and filth incapable of reducing the efficiency of the defensive function as against lepra so as to account for *maintenance*. General critique of opinions to the contrary. Remarkable example of the island of Madeira.

IV. Epidemiological facts show that lepra attaches to locality, or inheres in locality. Lepra comparatively rare among the population living on any endemic area nevertheless. Possible explanation. Value of the defensive function. *Microbes favorisants.*

V. The liberty of lepers severely restricted by law in five colonies of Australia. The origin and course of lepra on that continent entirely unknown. The five separate enactments consequently not based on any Australian evidence apparently showing that lepra is there *maintained* by communication with lepers.

Upon the whole, I fail to see that anything has been added to our knowledge of the ætiology of lepra, or clipped away from our supposed knowledge, which requires alteration in the critical remarks made several years ago by Hirsch,* save in one respect. The exception regards heredity. It has always been known, and of course Hirsch noted it, that heredity is no necessary factor in lepriasis. We see that leprosy in whites almost always occurs in Australia under circumstances which absolutely exclude it. I am aware of but one exception out of many instances. Secondly, it appears that, if heredity have any influence at all in this connection, at all events it is not the disease itself which is transmitted. No child ever has been born leprous, nor has any ever become leprous so young that it might reasonably be suspected of having suffered from birth.† But whether heredity were

* "Geographical and Historical Pathology."

† But see "Voyages cher les lépreux par M. le docteur Zambaco Pacha," Paris, 1891, p. 340; also the observation 5, p. 376.

a factor of more or less importance in determining lepriasis—that is to say, whether lepers could transmit a predisposition to their offspring—was a question which Hirsch inclined to answer in the affirmative. Recent investigations made on a large scale seemed to show that at all events heredity exercised no such indirect influence of that kind as could be appreciated. The Leprosy Commission in India did good work when they pointed out that leprosy in parents was not associated with an incidence of leprosy on their children greater than the incidence on children born of healthy parents, and living on the same leprosy area, on the one hand; on the other, that the parents of lepers were not lepers themselves in any greater proportion than other persons living on the same leprosy area whose children were healthy. And as to the practical question whether hereditary disposition were among the causes of the *maintenance* of lepra, the Commission showed very clearly that it might be excluded from consideration in all discussions of that point; for they showed, first, that lepers produce but few offspring at most; and, secondly, that such as they do produce are extremely liable to die at young ages from indifferent causes. Probably, then, heredity has no share in determining lepriasis, and certainly it has no share in *maintaining* lepra present among mankind.*

Only one other suggested explanation of the maintenance and diffusion of leprosy has received very general attention, and that is the contagion hypothesis. In accordance with the opinion I expressed at first, I think we cannot do better than follow Hirsch's account of it.

Hirsch pointed out, in the first place, that the doctrine of contagiousness had been in favour from the earliest times; but, then, there is no doubt the diagnosis of leprosy was but ill-established, and several other chronic and disfiguring diseases, and especially syphilis, were confounded with it. As long as the diagnosis of syphilis continued uncertain, so long did the doctrine that leprosy was communicable by the sick hold its ground. No sooner did men begin to learn to recognise syphilis with some certainty than the doctrine of the communicability of leprosy began to fall into disrepute; and at last it came to be almost entirely rejected. But soon after Dr. Hansen's discovery of the *B. lepræ*, in 1871,† opinion began to change again; and when Dr. Neisser, in 1881, sufficiently established a necessary or causative connection between Dr. Hansen's bacillus and lepriasis, the doctrine of communicability began once again to come into favour. That doctrine fits in so well with preconceived notions which date from antiquity, and is at first sight so natural, so easy, and so complete that it is not surprising that many of the profession as well as the public in general should have adopted it. But Hirsch pointed out—and his remark has all the force to-day which it had when he first made it—that in reality Dr. Hansen's discovery did not at all justify the inference commonly drawn from it. He said: "It is only an *à priori* proof of the conveyance of leprosy by contagion which Neisser adduces, when he states, on the ground of the finding of bacteria, and of the hypothesis therefrom deduced, that the malady is

* On these points compare Report on Leprosy in India, by T. R. Lewis and D. D. Cunningham: Appendix to 12th Annual Report of the Sanitary Commissioner with the Government of India, 1876.

† Leprosy: Hansen and Looft, trans. by N. Walker, London, 1895.

contagious in its specific products," and "contagious not only directly, but also indirectly, by articles which serve to carry the bacilli and their spores."*

That, evidently, is a just criticism; for what is required is proof that leprosy actually is directly or indirectly conveyed, and not merely an inference from analogy that it ought to be, or must be, so conveyed. But no sufficient experimental proof of Dr. Neisser's assumption ever has been given.†

In this discovery of the *B. lepræ*, then, and of its causative connection with lepriasis, we ought not to see a proof that leprosy is communicable by lepers; we should see in it only the proof that leprosy must be classed among the infective processes.‡ All the infective diseases are not maintained by communication with the sick, it will be remembered. Thus, tetanus is an infective disease; yet, as a matter of practice and of fact, tetanus is not maintained by communication between those suffering from it and the healthy.

Now, as to the direct communicability of lepra, probably no important difference of opinion longer exists. Probably no one of great weight would roundly deny that leprosy may, perhaps, be directly communicable from the sick to the healthy. We have, I think, no proof of it, but that is not a sufficient reason for denying it; and, indeed, there is one case§—though, as far as I know, one only—in which direct communication seems to have occurred: one only, I mean, in which the circumstances seem to have been observed and recorded with accuracy, and in which all causes but direct communication seem to have been excluded by them. On the other hand, I scarcely think that anyone of very great weight would at this day assert that leprosy was *maintained* by direct communication, in the face of well-ascertained epidemiological facts concerning this disease the world over. Here, again, we have not to go outside Australia in order to perceive that as a matter of fact leprosy cannot be directly communicated, except very rarely indeed at most. I know of only three cases out of many in whites (among whom alone the details can be accurately learned) in which known direct communication with a leper could have operated to cause the second case; and those instances are on all-fours with the examples usually cited in support of direct communicability, and, like them, are liable to criticism of damaging kinds. On the other hand, though we imprison our lepers rigorously as soon as we discover them, generally we do not discover them until they have been at large for several years; and yet fresh cases do not usually occur in the household in which they lived, and which was certainly thus exposed for long to whatever risk attaches to free communication with the sick, but by far most often in fresh households altogether.

That Australian experience is far from being exceptional. Everyone is familiar with the fact that lepers who have contracted their

* It should be noted that Dr. Neisser expressed this opinion nearly fifteen years ago. I do not know whether he has more recently confirmed it; if not, it is, of course, possible he might now modify or explain it. (*See* Virchow's Archiv, 1881.)

† Centralblatt für Bacteriologie und Parasitenkunde, 1893, vol. xiii.—Dr. Max Wolters.

‡ Report of the Leprosy Commission in India.

§ Dr. Hawtrey Benson's *Dublin Journal of Medical Science*, 1877. Professor H. Leloir also seems to regard the evidential value of this case as unique. (Traité de la Lèpre, p. 309.)

disease abroad return to Europe and live there in quite ordinary contact with others—sometimes at home, sometimes in the general wards of an infirmary or an hospital, and yet do not communicate their disease. There is, I believe, but the possible exception I have already mentioned, and one or perhaps two others which give ground for suspicion. We know also, and on the unusually good authority and personal observation of Boeck in 1870 and of Dr. Hansen more recently, that 160 lepers who emigrated with their families from Norway to some of the Northern States of America, and lived there under no restrictions at all, were found on being traced to have communicated their illness to no one—Norwegian, American, or other. So that, as regards direct communication of this disease, we may well admit that it is a possibility, and yet we can point to well-ascertained facts which at least forbid us to regard direct communication with the sick as the means by which leprosy is *maintained*, or to regard a leper as constituting any important danger to those who come into contact with him.

Now, if you feel inclined to disagree with that conclusion (notwithstanding your own Australian experience), you will have no difficulty in finding a hundred accounts which have been tendered to prove that leprosy is easily communicated by the sick, and that the disease is so *maintained*. I have but one word to say in reply. I merely ask you for the future to read those contrary accounts critically, and to accept those alone which are recorded with sufficient fulness as regards the essential details, and, at the same time, are entirely free from the *post hoc* fallacy. You will find that a vast majority of such instances are spoilt from the beginning by having been observed on areas of recognised endemicity, so that primary and secondary cases alike were under the influence of locality. Apart from that, you will find very few indeed which answer to the two requirements mentioned—one or both of them.*

After a not inconsiderable course of study, I take it that in any mind seized of the facts, and in the habit of weighing evidence, there can be no doubt at all about this: That lepra, if at all communicable by the sick, must be so only with great difficulty, and under special and quite unknown circumstances. Even some of the writers to whom I have just referred, and who have asserted that leprosy was so communicable (though without distinguishing between mere occasional communication, and such a common or frequent communication as would account for its *maintenance*), seem dimly to have perceived this; and, consequently, they usually postulate long-continued and intimate contact between the sick and the healthy as a necessary condition of communication. But you must perceive that this postulate is a sacrifice to a speculative opinion, for the records are full of cases of leprosy in which the sufferers never had been in long-continued, nor in close, nor in any conscious contact at all with any

* Nearly thirty years ago the Committee of the Royal College of Physicians remarked, in their Report (1867), that the cases cited to them in support of contagiousness either rested on imperfect observation or were recorded with too little attention to the necessary details to be of service. If the reader doubt whether it be still necessary to make a similar criticism, he need only refer to Dr. Hillis' work, 1881, pp. 177 *et seq.*, and to a work published more recently ("Leprosy," by George Thin, M.D., London, 1891), and peruse the very long string of "cases" cited therein, in order to satisfy himself that it is so.

leper. You will see this at once, too, because Australian experience of leprosy in whites shows, beyond possibility of doubt, that this disease can be contracted quite independently of intimate contact with lepers. Our own experience shows us that this can happen, and even that it most usually is the case. Now, if known long-continued contact with lepers is most often supported without the disease being communicated—I mean, of course, without any second case occurring in the household of which the solitary primary leper was a member, and therefore without even apparent or *primâ facie* evidence of communicability being afforded—we are logically warranted thereby in saying, not in general terms, that leprosy is a disease difficult to contract, or one to which a majority of persons are naturally resistant (for that would beg the question), but, at most, that at all events lepra is a disease very difficult to contract *from lepers*. And therefore, when on the other hand we observe that lepra very often does occur in persons who have been in no conscious contact with any leper, when we notice that close or long-continued contact with lepers is certainly not essential, we get (as it seems to me) a very important suggestion. The two facts taken together—for they are both well-established, commonly known, and such, moreover, as might be safely relied upon even if there were no other evidence of them than our own Australian experience—these two facts taken together seem to me to point to this: That leprosy may be a disease not at all difficult to contract, provided the virus in efficient form be met with under favourable external circumstances, among which presence of an actual leper is probably not essential.

There are two views which must be mentioned after setting out the foregoing argument. They are entertained by writers who either do not explicitly state that prolonged and intimate contact with lepers is necessary, or who implicitly deny its necessity by relying on indirect communication of the virus by the sick.

Those who do not explicitly require long-continued contact have pointed out that, as a very long latent period is commonly conceded to leprosy, it must always be difficult, and sometimes impossible, to trace the human source of the infection. I think this remark must have originated with someone not in the habit of tracing the course of outbreaks of communicable disease. If individual cases of lepra were alone to be examined, it would have great force. But it would have equal force if examination of individual occurrences of influenza or cholera were examined to learn whether those diseases were communicable by the sick, brief as the latent period is in them. It is not thus, in short, that the communicability of diseases is, or can be, established. The communicability of diseases can be examined only by comparison of the broadest epidemiological facts.

The other point has been indirectly raised by those who have suggested that lepra was *maintained*, not by direct communication with the sick, but by indirect communication—that is to say, by way of the soil infected by bacteridia cast off from the bodies of (tuberous) lepers. This view seems to have been based on an analogy with tuberculosis. In that disease living bacilli are known to be cast off, and are known to be capable of surviving in efficient form for long after they have left the body.

Now, first I must remind you, however tempting and probable the analogy may seem, that we know nothing whatever of corresponding facts concerning the *B. lepræ*. We do not in the least know whether it is an endogen or an ectogen. But, beyond that, we have seen that leprosy is communicated by the direct channel (if at all) with great difficulty. Whatever the reason may be, that seems to be the fact. That being so, I do not understand why it should be supposed to be more easily communicable by an indirect channel. If, nevertheless, it demonstrably were so (but there is no better evidence of indirect than of direct communication within households) the explanation would surely lie in the *B. lepræ* being an ectogen, and in its return to the earth or to some habitat outside man being a condition of the easy infection of fresh persons. It may be that indirectness of the channel was not supposed to enhance communicability, but merely to facilitate communication by bringing the virus into contact with a larger number of persons, and affording it, consequently, a freer opportunity of encountering the few among them who were susceptible. In that case imported lepers ought to establish new leprosy areas. This point requires examination at some length. It is crucial for any mode of communicability, and for my own part I do not think the facts support it.

We know perfectly well that imported lepers do not always create a new area of endemicity (if they ever do so), as they ought on the hypothesis of direct or indirect communicability. The case of the Norwegian lepers in the States is one in point; that of lepers returned to the cities of Europe is another. I refer again to these two examples because the facts concerning them are perfectly well established, and especially because the fact that these areas are not areas of endemicity is ascertained. I know you would have no difficulty in culling from books many round statements that such-and-such areas were contaminated by imported lepers, and were, in consequence, newly made areas of endemicity. Now, you will observe, no doubt, that if these assertions were substantial, if they were warranted by perfectly clear evidence, the whole question of the ætiology of lepra would be thereby settled once for all, and in the least disputable way. It would be proved thereby that leprosy was maintained by communication with the sick, and whether the mode were direct or indirect would become a secondary question and, for preventive purposes, no very important one. I lay stress, therefore, on the counter-statement which I am about to make. It is this: In none of the cases of alleged importation of leprosy which thus far I have studied have I been able to find anything that could reasonably be regarded as evidence of the assertion, vital though it obviously is. The datum, without which the whole case must fall to the ground, never is ascertained—namely, the freedom of the dwellers on the area under examination up to the date of the known importation of lepers.*

* The island of Madeira was uninhabited until it was occupied by Portuga in 1419. Emigrants from that country were introduced, many criminals and persons of the outcast class among them. Leprosy was then present in Portugal, as it was over the rest of Christendom. There is, therefore, every probability that lepers were to be found among the original settlers and later immigrants. Towards the end of the 15th century a lazaret was established on the island, which still exists, and from that date lepers have been present among the population. (Goldschmidt, op. cit. infra.) Viewed by itself this instance affords the best presumptive evidence—that is, the most certainly established in point of circumstances—with which I am

Thus, for instance, the prevalence of leprosy in Europe in the Middle Ages is frequently—and, I venture to add, lightly—ascribed to the return of leprous crusaders from the East. But according to Haeser,* quoted by Sir John Simon, notices of leprosy in Europe go back to the 4th century, and in the 6th and 7th centuries there were already leper-houses in France and Lombardy; and that makes it impossible to exclude the influence of locality, and to distinguish the alleged epidemic from recrudescence of a local infectivity. Then, again, you are all aware, doubtless, that the present prevalence of lepra among the natives of the Hawaiian Group has frequently been, and indeed is usually, ascribed to the importation of Chinese lepers about 1855 or 1860. But if you consult the papers on leprosy in Hawaii, collected by the Board of Health, and the review thereof by the Hon. Walter M. Gibson, the Minister who presided over the board and over collection of the documents referred to, you will have no difficulty in perceiving, first of all, that the beginning of leprosy in that group is unknown, and, secondly, that there is strong reason to believe that the disease was present among the aboriginals as early as 1822—and how much earlier no one knows, nor ever will know now. With these opinions Dr. Arthur Mouritz, who, as well as Mr. Gibson, had taken great pains to learn the history of the endemic there as far as it could be learned, agreed in an appendix to the collection, the whole of which was issued in 1886.† It is misleading to speak of such cases as those I have mentioned, and some others which you will notice from time to time if you read with sufficient cautiousness, as though there were evidence to establish a fact, and especially a fact such as this, which really is of fundamental importance. The truth seems to be—and all who have critically considered writings on the course of leprosy cannot but agree with me—that writers on this subject usually entertain the prepossession that lepra is *maintained* by communication with the sick, and forthwith either unconsciously bend the facts to accommodate their prejudice, or, which comes to the same thing, take for granted a great many important points as to which there is in reality no evidence at all.

Hitherto I have spoken only of a contagium, and of man, as though conjunction of the two were all that was necessary, and as though all men were equally susceptible. If it were thought that the contagium resided in localities, then very little could be said as to comparative susceptibility, for reasons which I shall give before concluding; but if it were assumed that the contagium was communicated by the sick, then it would be pretty clear that all men were not equally

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acquainted that leprosy can be maintained by communication with lepers; and it is remarkable that writers who hold contagionist views should not have made extended and special use of a case which furnishes them with unique support to their opinion. By the side of this example Dr. Ehler's account of Iceland (La Semaine Médicale, Nov. 17, 1894) and that of Leprosy in New Caledonia, and its transmission to the Ile des Pins, by Dr. F. Forné (Arch. de Médicine Navale, vol. 54, 1890, p. 185), have, in my opinion, but slight evidential value. And so with others. But as regards the subject of the present paper it will suffice to remind the reader that disproof of the hypothesis now put forward requires that some isolated area should be pointed out on which a population had lived leprosy free for long before leprosy began to spread among them subsequent to a known importation of lepers.

* "English Sanitary Institutions," 1890, p. 36. But also several other writers besides Haeser.

† Report by the President of the Board of Health to the Legislative Assembly of 1886, on Leprosy. Honolulu, H.I., 1886.

susceptible of it. Now, therefore, I must make further reference to the report of the Leprosy Commission in India, from which I have already drawn important details, although I find myself unable to accept all its conclusions.

The Commissioners espoused a theory of maintenance by indirect communication, which I have already mentioned; and probably they were aware of the difficulty I have just pointed out—that either there was in reality no good evidence of the spread of lepra by importation, or else that in ascertained cases, such as the importation of lepers in modern times to Europe or to America, it was clear that importation did not and does not give rise to new areas of endemicity. At all events, their reference to the function of natural resistance was by way of meeting this difficulty among others. They suggested that lepra would be likely to spread or to be maintained by indirect communication when the disease was introduced, or existed, among a people whose natural resistance was reduced by poverty in general—by food in some measure inadequate to physiological needs, and by the insanitary conditions usually found concomitant therewith. Notwithstanding the source of this view, I venture to say that I have not yet succeeded in seeing anything more than a platitude in it, no suggestion having been made (though an implication there unavoidably was) that reduced efficiency of the defensive function stood in any special relation to leprosy among all the infective processes. It seems to me, therefore, to be a generality. We are but just beginning to learn something of the physiology of defence, it is true; but clinicians have always observed that of all the not specially protected persons exposed to infection, whatever the disease might be, some resisted it and escaped. And clinicians have always seen reason to believe that poverty and filth in some form were predisponents to many of the infective processes, and therefore we may suppose it possible that they dispose to leprosy too. So that it must be asked what this proposed explanation amounts to. Does it exclude the inhabitants of any country? Are there at this day no poverty and filth in Norway, where lepra began to diminish long before the measures of partial and imperfect isolation in force there could have taken effect? Are there none in the great cities of Europe to which lepers return, and where they live harmlessly as regards their neighbours? And, after all, is it not the case that of all the poverty-stricken on recognised leprosy areas a very large majority escape the disease—that lepers are found, at most, in but very low proportion to the total poverty-stricken population? From the account of leprosy in Madeira, by Dr. Jules Goldschmidt,* let me give you a very striking example of this. On that island all lepers were never isolated, though about the year 1500 a lazaret was established to which poor lepers only were forcibly removed from all the parishes on the island until 1860; and since 1860 all lepers have been entirely unrestrained. The people themselves do not regard lepra as a communicable disease; they ascribe its occurrence to the use of a certain vegetable, and in consequence regard cases with perfect indifference, and live in quite ordinary contact with the sufferers. Now, the area of the island is very small —about 780 square kilometres—and its population is about 130,000, so

* "La lèpre. Observations et expériences personelles." Par le Docteur Jules Goldschmidt, Paris, 1894.

that the density is uncommonly high, or 170 to the square kilometre. The author said—and observe that he was not dealing with a matter of ancient history, but was giving the result of his personal experience during the past twenty-six years—that it might be taken that two-thirds of the close-packed population, or about 80,000 of the people, lived in *la misère* (a scarcely translatable term which means, on the whole, incessant labour rewarded by earnings which scarcely suffice to provide food adequate to the labourer's physiological expenditure), and that the state of the people was still going from bad to worse. Hence, if leprosy were maintained by direct communication with the sick, or by indirect communication, or if natural resistance to leprosy in particular could be impaired by a lifetime led in *la misère*, or if loss of natural resistance were indeed the determining cause of the endemic persistence of leprosy, then Madeira at all events ought to be ravaged by this disease. But what is the fact? The author reckoned but seventy cases in the whole island.

Thus I consider that the epidemiological facts no more support the theory of indirect communication than they support the simpler hypothesis of direct communication. This seems to me to be clear, but on the all-important condition that facts alone shall be allowed weight, and that guesses and assumptions shall be recognised and discarded. On the other hand, the character of leprosy, as deduced from a general survey of its behaviour the world over, is that of an endemic disease—of a disease which is essentially connected with locality. If a man visit a recognised leprosy area he runs an appreciable chance of contracting leprosy; but if a leper go to Europe his neighbours seem to be in no more danger of leprosy than they were before he returned among them.

If we confine ourselves to a pathological view, many of us will feel inclined to say that probable analogies class the *B. lepræ* with the endogens.* But, to the extent of my researches, the epidemiological facts seem to me to point to its being an ectogen; and not merely such an ectogen as the cholera vibrio, but rather such as is the bacillus of tetanus. Nor need it be supposed that on this view leprosy should be much more common than it is, even on areas of its endemicity. The defensive function is not to be undervalued. It may well be that our phagocytes are usually victorious over that ancient enemy, the *B. lepræ*. But beyond that we now know, thanks to the labours of M. Metschnikoff (cholera†) and MM. Vaillard, Vincent, and Rouget (tetanus‡), that successful infection is not always due to weakening of the defensive function by agents which are "depressant" in general terms. Men do not acquire tetanus, for instance, merely because they happen to be out of health when they receive the virus; clinically no fact is better known than that, I suppose. Nor do those who drink too much beer or eat too much fruit during a cholera epidemic succumb to cholera merely because they have become generally depressed by drunkenness or by diarrhœa. No; it is the concurrence with the *B. tetani* and the *Vibrio choleræ* of other organisms—quite

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* Cf. E. Klein, Pathology of the Infectious Diseases in "A Treatise on Hygiene, edited by Stevenson and Murphy, 1893.

† Ann. Inst. Pasteur, 1893-4.

‡ *Ibidem*, 1891-2-3.

harmless in themselves, it may be—which gives those bacteria their surest opportunity of evading the natural defenders of the body against them. Thus, if we supposed for a moment that concurrence of some other sort of organism with the *B. lepræ* were necessary to successful implantation of the latter, we could understand how it might happen that of all the people living on a tract of country freely infested with the cause of lepra only a few would become lepers. Do not forget that all this is but speculation as regards leprosy. I think it is surely founded on ascertained epidemiological facts; but through experiment alone can the superstructure be safely raised.

When I framed this communication I had no intention of producing a mere polemic. Probably that is evident from what has now been said; and in that case you will, perhaps, have been surprised that I have but little referred to the course of leprosy in Australia. I presume that each of the five Governments took the rational precaution of ascertaining what that course had been before enacting the extremely severe laws against the liberty of lepers which they have adopted, and at this moment enforce in five colonies—before they ventured to add the remarkable hardship of imprisonment for life to the affliction of incurable disease. I cannot suppose that they failed to do this, although no evidence of it has ever come to light; for I will not suppose that with ample medical advice at their command they treated their people like chattels, and as though, if in those enactments they should ultimately find they had fallen into error, they could defend themselves by airily alleging that at all events their mistake had been on the right side. I will not for a moment entertain a supposition so injurious—injurious not merely to Governments, but to the people who otherwise acquiesced in a flagrant infringement on personal liberty. Doubtless, the facts regarding leprosy over the world in general, and particularly the facts regarding leprosy in Australia, were carefully gathered and critically examined before so momentous a step was taken as that which declared that every leper should for the future be rigorously imprisoned for as long as his incurable malady should permit him to survive—that he himself and all his family should for ever suffer because it was essential to the public good.

And yet the people, and yet you yourselves, do not know the precise grounds on which those enactments were based; you do not in the least know what the course of leprosy in Australia has been; you cannot tell whether it has been such as manifestly supports, or merely fails to support, or manifestly contradicts the belief that leprosy is *maintained* by communication with lepers. For want of that information the salient characteristic of those laws must seem, in the eyes of some, to be renascence in the 19th century of the product of mediæval ignorance into mediæval egoism. Should not the strong evidence which, no doubt, exists in the archives of one or more of the five Governments to show that the practice of the Middle Ages was wise and indispensable, and therefore still is necessary in Australia, be now—though late—produced to us?

2.—EFFECT OF THE QUEENSLAND GOVERNMENT EDUCATIONAL REGULATIONS ON THE PHYSIQUE OF THE PRESENT AND FUTURE NORTH QUEENSLANDER.

By JOSEPH AHEARNE, L.C.R.P., Lond., &c.

My search into "The Effects of the Queensland Government Educational Regulations upon the Physique of the Present and Future North Queenslander" has satisfied me that their unmodified establishment in North Queensland is harmful, and I trust when I have finished my address I shall have induced my listeners to arrive at a similar conclusion.

Now what are these regulations it shall be my duty to arraign—

(*a.*) The statutory age is unquestionably too low.

(*b.*) I have to assert that those which provide for the establishment of State and Provisional schools are incomplete, as the highly important questions of site, form, lighting, seating, and ventilation lie in the hands of untrained persons ignorant of hygienic requirements.*

(*c.*) I have to complain of the time-table which requires children to attend school in the afternoon.

(*d.*) I have to express the opinion, strengthened by the valuable testimony of some able teachers, that the standards of proficiency are too high.

(*e.*) I have to draw attention to the unsuitable time of year for holding the scholarship examinations.

(*f.*) I have to condemn in emphatic terms the cruel treatment to which are subjected those young girls unfortunate enough in having foolish parents who permit them to become pupil-teachers.

Before discussing these points in detail, I ask you to follow me in glancing at North Queensland's situation, and reflecting upon its climate.

From Thursday Island in $10\frac{1}{2}$ degrees to Cape Palmerston in 22 degrees 40 minutes south, you will see the coast line of the territory which is now engaging our attention.

The interior of the Northern Territory of South Australia north of 20th parallel is a region with a mean summer temperature in excess of 95 degrees Fahrenheit; and the whole of the country, excepting the seaboard, lying between the meridians of 120 degrees and 140 degrees and north of the 25th parallel, has a mean temperature in excess of 90 degrees Fahrenheit.

The climate of the Northern Territory is therefore extremely hot, except on the elevated tablelands. Altogether the temperature of this part is very similar to that of Northern Queensland, and the climate is equally unfavourable to Europeans.

The mean temperature at Brisbane during December, January, and February is about 76 degrees, while during the months of June, July, and August it averages about 60 degrees. The winter in Rockhampton averages nearly 65 degrees, while the summer heat rises almost to 85 degrees; and at Townsville and Normanton the average temperature is still higher.

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* The site is reported on by the District Inspector, and the other matters are dealt with by officers of the Works Department.—*Editor.*

Mr. Anderson, assistant of Mr. Clement Wragge, has kindly given me the mean temperature for the eight hot months of the North Queensland stations; in each it borders on 80 degrees.

In the tropics the white race has two irreconcilable enemies—*anæmia*, a condition in which is lessened the important agents that give redness to the blood; and *malaria*, a soil disease of parasitic generation, and anæmia's close ally.

Oxygen is the vital principle of air. While life exists, heat and force, both mental and physical, are produced; as heat to boil the kettle, and steam to drive the engine, are obtained from the union of oxygen with wood and coal, so the body's heat and force result from the chemical contact of inspired oxygen with the carbon of the system.

So, having the carbon, to obtain a desired quantity of heat and force, the supply of oxygen must be sufficient.

In the living man if oxygen be deficient then combustion is retarded. A proper bulk may be wanting from two causes—either a diminished percentage of this gas in the atmosphere or a reduction in the number of the corpuscles designed to convey it along the sanguineous stream.

How does the first cause operate? Each rise of 1 degree in temperature increases the expansion of air by $\frac{1}{480}$ part of its volume, so that air at 80 degrees Fah. would be rarer by $\frac{1}{24}$ than air at 60 degrees Fah. Taking the respirations at fifteen or sixteen per minute, the loss of oxygen every twenty-four hours in the higher temperature is a very appreciable amount.

It has been calculated by Rattray that in India the adult uses nearly 37 cubic feet less of air daily than he would in England.

Oxygen is lessened, the army of its red carriers is reduced to a tropical footing, thus lowering the power of resistance to heat, of endurance of fatigue, weakening the defences against disease, and preparing the tissues for premature decay.

And malaria, whether insidiously insinuating itself in the form of continued fever or brazenly seizing and striking down its victim with virulence in ague, stands out as a destroyer of red corpuscles. It is universally agreed that long after removal from its habitat, an unsuspecting subject of its dormant influence may develop active symptoms from a lengthy incubation.

Then, as well-aerated blood is necessary for the proper nourishment of all parts of the body, and since, even in the uncomplaining apparently healthy individual, tropical heat interferes with this accomplishment, we have impaired digestion and a lowering of nerve vigour. The skin is an active eliminator, leaving the lungs much less to do, consequently the chest of the child is not developed to its full extent.

This becomes a hardship and a danger if in adult life a change to colder climates should be necessary or desirable.

In the words of Lauder Brunton, "certain organs of the imported European are manifestly called upon to exert themselves less than formerly, while others are worked beyond their wont. The thoracic viscera are spared, but the liver, spleen, intestines, and skin, which have functions to perform in excess of those thrown upon them in a temperate climate, are particularly liable to undergo pathological changes and to suffer from actual disease upon the occurrence of any exciting cause."

The vast majority suffer to some extent, particularly the women; so if the parents are languid, debilitated, and generally anæmic, we must realise that the children do not derive that stamina which is transmitted in our natural homes.

Two more authorities I quote, who speak with the weight that long residence in India and close investigation there justify. Sir R. Martin's opinion was that, although with care the European child may be reared in India up to five or six years, beyond these ages a physical and moral degeneration occurs; the child then "exhibits the necessity for change of climate by emaciating and outgrowing its strength," and he considered the attempt to rear children up to and past youth is "an altogether cruel and impracticable endeavour. Even those who are kept in India till five or six only exhibit a restlessness and mobility of the nervous system—a busy idleness—beyond their age, as compared with the habits of children of the same age born and bred in England. There is also a marked disposition to relaxation and to a loose relaxed state of the joints in such children, and to consequent lateral curvature of the spine."

Hear Fayrer's following sentences:—"It has long been known to the English in India that children may be kept in that country up to five, six, or seven years of age without any deterioration, and in the higher classes of life with probably as little, if not less, danger to life than in England; for most assuredly in some respects—as, for example, scarlatina, measles, whooping-cough, thoracic complaints, and even dentition—they suffer less in India than in England. But after that age, unless a few hot seasons spent in the hills should enable parents to keep their children in India until a somewhat later age, to do so is always a doubtful proceeding."

Then what type has been evolved as suitable to places of high temperature?

Examine the belt lying to the south and north of the equator, and note the c l)ur of those inhabiting the countries between Capricorn and Cancer. They are all black or coloured.

Professor Seeley, in his book on "The Expansion of England," says, "Nature has made the colonisation of India by Englishmen impossible by giving her a climate in which as a rule English children cannot grow up."

To come nearer home in support of this opinion, I shall read you an extract from a letter generously written to me by our sympathetic Governor, on his receipt of an address which some time ago I read as President of the Medical Association in the North—

"The question raised in your circular of queries to the medical men of Northern Queensland is one of much importance, and I think that the subject is one which may well engage serious attention for many years to come.

"Of course, as yet in Northern Queensland there has not been time for a second generation of pure Queenslanders, or, at all events, of pure *Northern Queenslanders*, and I believe that in India the pure whites do not fail till the third generation. Indeed, the third generation without fresh blood is almost unknown.

"In the West Indies, in latitudes 12 degrees to 18 degrees, there are pure white families who have been in the islands for 200 years—say, for six generations—and some of these are fine specimens of humanity, others are *undoubtedly* degenerated; but why there should be so much difference in this respect between the East and West Indies, to the disadvantage of the former, I do not know, especially as for five months in the year there is a bracing climate in the East Indies which is unknown in the West Indies."

The stalwart West Indians, whom Sir Henry had in memory when he wrote, no doubt are of the planter class. We know under what favourable conditions their lives were spent; the children went home to England for school; both fathers and mothers made frequent and lengthy visits to the old country. During their stay in the islands, in the royal days of sugar, all the means that could modify the effects of climate were adopted freely; residence in the hills, suitable houses, retirement in the hot hours, rational meals, all prevented nerve exhaustion, and preserved their type.

The Anglo-Saxon in North Queensland, however, has got as far away from Britain as is in his power to get. No going home to school at six to eight years of age to grow up an English boy before the climate overcomes the racial influence; no yearly trip for the parents after the season's crop is finished and the year's work is done. Nothing but the high-pressure exposure without a break from January to January again. And what is the penalty to be exacted? Decline of the parents, with a progressive degeneration of the children?

In this connection I may quote here a short extract from a paper on "The Migrations of the Races of Men considered Historically," read by Professor James Bryce in 1892—

"It is, of course, possible," he says, "that the great European peoples, or some of them, may after a few generations acquire the power of thriving in the two tropics, of resisting malarial fevers, and of rearing an offspring which need not be sent home to a cold climate during the years of boyhood. We may call it possible, because our experience is still too short to justify us in calling it impossible. But it seems so far from probable that, in considering the future of the leading and ruling races of the world, we must practically leave their permanent settlement in the tropics out of the question, and restrict our view to the two temperate zones."

It may be said that the Indian climate is more enervating, the Indian heat more excessive, than we experience in North Queensland. But have we not, as in India, the liver diseases of men, the menstrual excesses of women, the anæmia, dyspepsia, neuralgia, and fevers common to both?

Have we not the rapid growth, emaciation, and narrow chest after the ages of six or seven? Have we not a death-rate amongst children sufficiently higher than that in sub-tropical and temperate Queensland to prove how undesirable is the outlook for our young fathers and mothers?

I extract from the Registrar-General's reports for the past five years some portions of his remarks on mortality generally, and particularly on that of children under five years of age. Of 1889 he writes: "It has been considered by some that the climate of Queensland is unfavourable to children, and the proportion of deaths of children under five years of age has been adduced in support of this. It must be admitted that the proportion of deaths of children in this colony does not compare as favourably as could be desired with many other parts of the world. The highest death-rate appears in the Kennedy district." In the list of nine districts tabulated I find that Townsville ranks next to Kennedy. For 1890 he says, "The highest death-rate to the total deaths in each district appears in the Kennedy district," again Townsville comes next. In 1891, "It appears that the greatest number of deaths occurred in the first and fourth quarters of the year, but the deaths which occurred during the first quarter were the most numerous. This has been generally the case in previous years, no doubt the warm summer months contributing somewhat to the number of deaths, particularly amongst children."

Under his five years' table, he there states, "From this it will be seen that the highest rate of deaths of children, both under two and under five years of age, to the total deaths in this district and colony occurred in Kennedy, in which district the town of Charters Towers is situated. Townsville, though much behind, comes next."

In 1892, he says, "As is usually the case in the second and third quarters, the number of deaths registered was not so great. It will be seen that as in 1892, so also in the previous year, the greatest number of deaths was registered in the first and fourth quarters. The heat of the weather at that period in this colony has no doubt a great influence on the degree of mortality, especially amongst very young children."

Of 1893 the Registrar-General writes: "The quarter of the year which includes the months of July, August, and September is evidently the most favourable to a reduced rate of mortality in Queensland. The first and fourth quarters in which great heat is experienced are just the opposite. The large proportion of Queenslanders who die affords an illustration of the extent of the loss to the population which occurs amongst the most youthful portion of the native-born, and which it is certain is for the most part preventable. The extreme heat of the summer months in this colony, especially in the North, is somewhat trying to young children. Thus in Kennedy, of which Charters Towers is the chief town, almost half of the deaths are of children under two years of age, and 55·71 per cent. did not reach five years. Townsville comes next."

The unprejudiced man of figures, then, has proved for us that the hot months are destructive of young life, and that the districts where the heat is hottest and lasts the longest have the highest death-rate.

And of those who escape I may here refer to a nervousness—a high state of tension—that is very evident amongst them.

I addressed myself to the head teachers of the different schools in North Queensland, asking for information which would enable me to compare North Queensland chest measurements with an accepted home standard.

Most of the teachers on the coast responded. I did not have a sufficient number of replies from the interior to be of much value. But of the interior we have at Herberton only an exceptional elevation, and even of recognised hill stations an authority says, "Although such a climate would at first sight appear to offer an environment within the tropics suitable to acclimatisation of the Northern races, there are elements which detract from the advantages of hill climates There are the rarified air affording a lessened supply of oxygen, the heat and direct rays of an intertropical sun, and the absence of well-marked seasons, which perhaps afford the greatest vitality to the European races." The comparisons with which I now trouble you are between boys on the sea border and boys of the same age in England, according to Maclaren's tables:—

The average girth of chest of 100 boys in England.		The average girth of boys from Townsville, Brandon, Port Douglas, Thursday Island.
At 10 years is 25¼ inches	...	At 10 years is 24 inches (12 boys)
" 11 " 26¼ "	...	" 11 years is 24⅞ inches (9 boys)
" 12 " 27½ "	...	" 12 years is 25½ inches (11 boys)
" 13 " 28½ "	...	" 13 years is 26 inches (14 boys)
" 14 " 29½ "	...	" 14 years is 27 inches (4 boys, 2 Bowen, 1 Bowen 31¼)
" 15 " 30¾ "	...	" 15 years is 28 inches.

When the arms are placed horizontally, during moderate expiration, the circumference immediately under the nipple and the angles of the shoulder-blade should be equal to half the length of the body. Now, in North Queensland I find that the half mean length of the bodies of 58 boys exceeds the mean circumference of their chests by $1\frac{15}{16}$ inches. So, to that extent, a North Queensland boy is taller than his girth of chest demands.

North Queenslanders should not be sent to school at the early age of six. I bring the Registrar-General once more to my aid, who, in his last report, remarks, "It will be observed that, whilst children under five years comprise about two-elevenths of the population, they contribute four-tenths of the deaths, and the females in greater proportion than the males. Young people from ten to fifteen years of age, as is usually the case, were exceptionally free from fatal illness." So that the nearer to ten the better the health and strength. I am pleased here to congratulate Mr. Cross, M.L.A., on his sensible remarks that appeared in the *Hansard* of 24th October. He speaks with practical knowledge and pardonable satisfaction of the result in his son's case, obtained by what the educational authorities would call a very late beginning in learning.

His own words are, "From five to eight or nine years of age the bodies of children, and their brains, too, grow very fast, and the opinion of many experts was that sending children to school at a very early age was the cause of many of the diseases from which they suffered. He knew several persons who had tried the experiment of keeping their children away from school until they were eight or nine years of age, and the experiment had proved eminently successful. He had kept his own boy from school until he was nine years of age, and, though he had received no education at home, his progress had been wonderful." I learn from the Hon. Robert Philp that the minimum statutory age in New Zealand, South Australia, and Tasmania, is seven years.

A primary matter for attention is obviously the selection of the most sanitary site available. Sandy soil is the most objectionable, as over it radiation is slow and the atmosphere during the day is hot. Glaring ground reflects both light and heat. Clay is much better. Vegetable mould is the best non-absorbent of heat. The neighbourhood of trees should be chosen for erection of the school-house. In barren localities every effort should be made to encourage their growth. The beautiful evergreen shady mango flourishes in North Queensland, requiring no care, but only protection in its tender months from the straying goat and cow. Apart from improving the landscape, trees modify and regulate the heat; they cool the air by evaporation in daytime, and interfere with the absorption of heat by the ground.

The buildings should be high enough to prevent the entrance of ground air, and they should be faced so as to receive the modifying influence of the prevalent monsoon.

The plans issued from Brisbane are of a uniformly stereotyped character, and do duty from cold Cambooya to Thursday Island in Torres Straits. As the English code has it—"School planning is the science of thoroughly adapting every part of a building, even the minutest detail, to the work of school teaching." Convenience, suitable lighting, proper subdivision into classes, thorough ventilation, are its leading essentials. Great care should be taken to render the roofs impervious to cold and heat. Each classroom should be easily cleared without disturbance to any other room. Every part and corner of a school should be fully lighted. Light, as far as possible, and especially in classrooms, ought to be admitted from the left side of the pupils.

Windows fixed in front of teachers or pupils are condemned in England: so placed they provide the most injurious light; it brings pain to the eyeball and wearies the retina, to avoid which the child holds the book so as to encourage short sight, or twists his body and so induces distortion.

Although the Germans have an undesirable pre-eminence in the number of youths and adults who wear spectacles, it is an established fact that in England and America myopia (near-sightedness) is increasing.

Let Mr. Brudenel Carter show the signification of this. "It will be manifest," he says, "on reflection, that the matters which are lost by the short-sighted, as by the partially deaf, make up a very large proportion of the pleasures of existence. I am accustomed on this ground strongly to urge upon parents the necessity of correcting myopia in children; and I am sure that a visual horizon limited to ten or even twenty inches, with no distinct perception of objects at a greater distance, has a marked tendency to produce habits of introspection and reverie, and of inattention to outward things, which may lay the foundations of grave defects of character."

Desks and seats should be suitable to the height of those using them, and arranged to receive the best available light. To prevent the possibility of an intelligent teacher modifying the effect of faulty construction by changing the desks and seats to the best positions, these in our schools are firmly, rigidly fastened. Unsuitable desks and uncomfortable seats help short-sightedness, and are distinctly responsible for the deformity of spinal curvature.

I have already brought evidence to show the loss of healthy proportion between chest development and height. After six or seven years old the chubby youngster loses its condition, with its dimples, and stretches skyward at the expense of width and with the loss of muscle. An observant correspondent, who writes in the *Sporting and Dramatic News* of last September, says: "What explanation can our scientific brethren give us of the undoubted fact that both Englishmen and dogs born and bred in India have a tendency to run to length of leg and nose? No better example of this can be found than that of Indian bred bulldogs, which after a few generations become quite snipy in appearance."

As it is latterly not a rare thing to hear of curved spines in the North, I may be permitted to quote Leibrich, the German authority, on this subject. He remarks that if a child has to read a book placed at too great a distance it sits on the edge of the seat, a very unhealthy and fatiguing position. It rests the body on the two arms; and if the difference between the height of the desk and seat is too great, the chest is supported by the projecting shoulders, instead of the shoulders resting on the thorax. Soon this position becomes too fatiguing; the head, bent forward, becomes too heavy, and must be supported by one or both hands at the temples, or by the chin resting upon both arms. It is still worse when writing. With desks and seats of the ordinary form only, one arm rests on the table; this is generally the right, while the left hangs so that the elbow approaches the left knee, and only the tips of the fingers hold the book on the table. The edge of the book is no longer parallel with the rim of the table, but slanting or even perpendicular to it. If we observe the position which the upper part of the body assumes, we find that the lumbar vertebræ bend forward, those of the chest toward the left, and those of the neck forward, with an inclination to the right; at the same time the lower part of the shoulder-blade stands too far off from the ribs, and is elevated too much towards the right, and the shoulder joint is raised and pushed forward. To be in such a position for several hours of the day, at a time when the youthful body is rapidly developing, must naturally produce bad results.

Ventilation must not be passed over lightly because we have a climate in which the doors and windows may be kept open. In our hottest and most depressing time of year light airs from the north prevail. Even these may cease when the clouds are heavy and low, so that the natural diffusion of gases is much retarded. Overcrowding in comfortable rooms increases the carbonic acid to 0·7 per 1,000; in badly ventilated sick chambers by 2·4; in over-crowded halls, 3·2; in pits, 4·9; in schoolrooms, 7·2 per 1,000. In addition to the carbonic acid we have to consider the excretions from the surface of the body that give a distinct odour to the air, quite recognisable by the sense of smell. The organic matter thus put in circulation is extremely injurious to health; the more so as it is not easily disposed of by opening the windows, for it adheres to clothing, curtains, and furniture.

School hours continue till 4 p.m. This is perhaps the most serious defect of the system; on it other grievances rest. It compels most children to grow up without sufficient nourishment. A proportion of them eat but scanty breakfasts, the majority do not go home to mid-day dinner; their homes are too distant or their games too attractive.

Dried-up bread and butter, or probably decomposing sandwiches, are the only support until their return at 5, when most likely and naturally the mother gives them a piece, which affects the appetite for the evening meal.

Growing children need food more often than adults; they cannot and ought not to take in too much at a time, while they use it up very quickly owing to the rapidity with which the processes of life are carried on. Rapidly growing boys in particular should be hungry all day long. Children with gnawing stomachs are not in a fit state to receive instruction of any kind. From 2 till 4 much physical harm is done: the pupils fall asleep; they have to be prodded up; the teachers are too lazy to whack in the afternoon; the forced brain efforts affect other parts by drawing too long on the life-giving fluid, for the amount of blood contained in the body is insufficient to fill the whole of the muscular system at once. It is necessary that, when one part receives too much, another should be receiving a smaller supply of blood.

Just here I would bring under notice some advice of Mr. Sharpe, the senior chief inspector of schools in England:—

"The duty of a manager is to keep before him the picture of a little child, and to regard a little child under conditions—

(1.) The physical conditions of health necessary, both for rest and action—*i.e.*, a merry, well-developed child.

(2.) The intellectual condition of attentive watchfulness—*i.e.*, a questioning not passively receptive child, a child seeking for knowledge spontaneously and eagerly."

The standards of proficiency are too high; a little child of eight may have to manipulate 999,999,999, and to know Roman notation to D. Teachers complain of the multiplicity of subjects. "As the schedule now stands," writes one teacher, "the amount of work to be got through in the upper classes is undoubtedly too great. This remark applies to the whole colony, though naturally the difficulty is greatest in the North. Opinions differ as to what should be cut out. My own opinion is that quite half of the work set down under the head of 'object lessons' might be swept away with great advantage to all concerned." Another advises that there should be no set reading books—only books on history, travel, and on general information. Instead of pushing arithmetic to the extent now done, he would have only easy stock sums, and profit and loss problems. I find that there is no algebra or Euclid taught; the system then is accountable for the absence of training in deductive reasoning; there is no knowledge of argument. Feeding with little bits of information is not teaching to learn, and this is the course pursued in the object lessons.* In half an hour moral instruction, domestic economy, temperance, first aid in accidents, agriculture, mechanics, conduct and manners are to be touched on. The teacher exercises only the brain, which we have in common with the lower animals, and leaves the higher cerebral localities undeveloped. At eleven and a-half a girl may be examined about atoms and molecules, amyloids, and plastic food substances before she can light a fire, and without knowing how to cook a potato.

Examinations are held at the wrong time of year. In Brisbane, in December, you can ask yourselves if you feel braced up for continued effort; how much more must the strain be 800 or 1,000 miles

* The writer has been misinformed on this point.—*Editor.*

nearer the equator, amongst children enervated by the higher, more depressing, temperature of a longer continued summer?

I have had many little patients every year suffering from enlarged flabby tonsils, loss of appetite, sleeplessness and constipation—all traceable to undue pressure upon anæmic subjects. Without hesitancy I say that early deaths and broken constitutions will result from the Christmas examinations. I am reminded of Mr. Diggle, of whom we have heard, recently more than ever, in his struggle for ascendancy in the London School Board. Addressing some little boys and girls—good, bad, and indifferent—he quoted the inspiriting example of a model scholar. First he won an exhibition, then he went on to the City of London School, where he picked up prizes as easily as other boys learn slang. Presently he won an open scholarship, and came out in the first class. Finally he was made a fellow of his college—finally? No, the end was that his health broke down, and he died as the good boy does. There is a moral here for parents to draw; youngsters who refuse to be overworked can draw it for themselves.

And now for the unfortunate females who become pupil-teachers; let us see how their day is spent. Of course you know that these young pupils are themselves taught, and have to prepare for periodical examinations, the subjects that are laid down in Schedule VII. of the Regulations. One hour and a-half of each day must be devoted by the head teacher to their instruction; of this time not less than half must be before the regular school hours in the morning, and no part must be during the midday recess. Let us assume that one-half of this time is taken in the morning, the other in the evening. The girls must be at school by 8, therefore they start the day by 7 o'clock. They must teach during the ordinary school hours, and do such other work as the head teacher, subject to the Regulations, may require; they are not allowed to leave the school for dinner, but have to occupy themselves in this time examining and correcting children's exercises. The second half of their instruction by the head teacher retains them till 5 p.m., then to home; it may be a long distance. After tea come lessons, sometimes till 10. Portions of Saturdays and Sundays are often encroached upon to make up lost time in some of the numerous subjects required of them. If they get up sharp at 7 only, and go to bed promptly at 10, they have fifteen hours of a working day, except the intervals for breakfast and tea. *What* a breakfast they surely eat, poor girls! and how they must enjoy their teas! But do you think the weary brain gets healthy rest during the hours they lie in bed? No! "Our foster nurse of Nature is repose, the which she lacks." With nervous system unrelieved of its anxiety, and muscles still fatigued, the morning calls them to another day's routine of toil.

Previously I have mentioned that tropical residence increases the physiological monthly change in women—it commences earlier. From observations it is concluded that European girls born in the tropics menstruate about one year sooner than girls of English birth and rearing. All hæmorrhages diminish the number of red corpuscles, those little bodies I referred to as carriers of oxygen in the blood. In the hæmorrhage I am now discussing, a moderate loss of red corpuscles is replaced within twenty-eight days; but we must have favourable conditions for this desirable recovery. Now, what life could be more unfavourable than the one which these girls are forced to lead?

Nervous depression and general relaxation characterise them; a sudden increase of moisture in the atmosphere lessens the moisture given off by the skin and lungs, with the result that blood is driven to the interior. If hæmorrhage is taking place at the time, it will of course be increased: rest is out of the question; the vital processes are lowered. A rapid fall in temperature will have the same effect. Can we wonder that these girls become pale and languid and of poor physique? One male teacher described the system as fairly taking away the girl's womanhood. Can we contemplate with satisfaction the far-reaching effect upon the unborn children, who will owe their physical degradation to the slavery imposed on their maternal predecessors?

I have endeavoured to show that the tropics have an injurious effect upon adult Europeans—that their children develop into a more nervous, slighter, and less enduring type. I claim, then, that school regulations which are not specially prepared for them, but are applicable in temperate countries, are hurtful to the North Queensland boy and girl, and therefore to their successors.

The age limit, the design of the building, the time-table, the standard of proficiency, the period for holding the annual examinations, all require serious attention from the authorities in Brisbane.

3.—THE PROMISE OF SERUM THERAPEUTICS IN RESPECT TO TUBERCULOSIS.

By J. SIDNEY HUNT, M.R.C.S., Eng., Hughenden, North Queensland.

Since the discovery of the famous tubercle bacillus by Koch in 1882, there is probably no condition of disease which has been the subject of greater interest to the world at large, and to the scientific section of it in particular, than that to which this bacillus gives rise. This interest is necessitated by the vast importance, the wide incidence, the protean manifestations, and the intractable nature of those morbid processes which result from infection by the tubercle bacillus, and which, by the recognition of this organism, we are now able to group together under the common name of tuberculosis. We now know that the one essential factor in tubercular processes, whether those processes occur in the human being under the name of "phthisis," or in the skin as "lupus," or in the glands and joints as "scrofula," or appear as multiple tumours on the serous membranes of beasts, or as abscesses in the necks of pigs or in the udders of cows, or as ulcers in the throats of fowls, or in a hundred other forms, is the invariable presence of the specific bacillus. True, the tubercle bacillus does not under all circumstances present precisely the same morphological appearances; but its slight modifications are only such as may reasonably be attributed to variations in the soil in which it grows, as, for instance, in the case of man, of cattle, or of fowls. Essentially it is the same bacillus for all; it has the same peculiar staining reactions, the same kind of growth in artificial cultivation, produces in all the same kind of destructive lesions, and, above all, is intercommunicable between man and various animals, and between animals of various kinds. Hence the efforts to combat tuberculosis have of late years been mainly directed, one way or another, against the tubercle bacillus itself. If these efforts have not so far been attended with any great measure of success, it is not, as the bulky literature of the subject shows, owing to any lack of effort or ingenuity on the part of those who have been engaged in them. The mere mention of the methods that have been advocated and tried would be quite beyond the scope of this paper. But the "plan of campaign" against the *Bacillus tuberculosis* as hitherto carried out may be considered as roughly consisting of two parts—the one of defence, the other of attack.

In the way of defence, it has been sought in various ways to strengthen the natural existence of the organism invaded, for there exists in the blood and tissues of all healthy animals a certain, though varying, degree of resistance to every kind of bacterial infection. To this end hygienic surroundings—general and climatic—pure air, sunlight, good food, galvanism, physical exercises, oils, and innumerable drugs of the "tonic" kind have been advocated.

In the way of attack there has been, perhaps, more activity—certainly more innovation. The total destruction of the bacillus and its spores by some substance deadly to it, but harmless to the animal in whose tissues it is imbedded, is doubtless an ideal method of attack, but it is, unfortunately, for very obvious reasons, impossible to administer any substance of the "germicide" or "antiseptic" class—such as carbolic acid or corrosive sublimate—in quantity sufficient to destroy the bacillus without at the same time destroying or seriously injuring its host. Nevertheless, a vast number of substances of this class have been employed, not for the most part with the idea of directly destroying the bacillus, but in the hope of impairing its vitality, diminishing its toxic power, neutralising its poisonous products, or limiting its reproductive activity (spore formation), and in these ways indirectly helping the organism to resist it.

The introduction of Koch's tuberculine in 1890 marks a new departure. Tuberculine is essentially the poison (or poisons) elaborated by tubercle bacilli in artificial cultivation, freed from the bacilli by filtration. Its effect when injected into a tuberculous subject is to destroy the morbid (tubercular) tissue in which the bacilli are imbedded. This destruction of tissue is accompanied by a rise in temperature, a fact which makes tuberculine of the greatest value as a means of diagnosis. It has certainly not fulfilled the hopes that were entertained at the time of its introduction; nor, I venture to think, is it reasonable to anticipate any great benefit *so far as its destruction of tubercular tissue is concerned.* It has, however, in all probability, other effects upon the system which, judging from analogy and by the light of recent investigations, may yet prove of paramount importance in the treatment, and perhaps even prevention, of tuberculosis.

The researches to which I refer are those relating to the natural, acquired, or artifically produced immunity to bacterial diseases, particularly those of Ehrlich, and of Behring and Kitasato.

It has long been known that persons who have recently suffered from a zymotic disease, such as smallpox or typhoid, are for a time, and, in some cases, for a very long time, proof against the same disease. And the same phenomenon is observed amongst animals, as, notably, in the case of anthrax. The aim of "vaccinations" and "protective inoculations" is to produce this state of insusceptibility or "immunity" by introducing the specific microbes in a modified form, and so producing a modified form of the disease. As to the essential nature of the immune state, however, there has been much difference of opinion.

There was first the theory of *exhaustion*, to which at one time Pasteur lent the ægis of his support. This theory assumes that the microbes of an infectious disease use up or exhaust the supply of some particular substance necessary for their development, and that this substance is not subsequently reproduced—and hence the immunity. This view is, I believe, now generally discarded.

Then there was the *retention* theory of Chauveau. By this it was supposed that certain substances, produced by the activity of the microbes, accumulated in the system, and were subsequently retained, and, being prejudicial to the particular micro-organism that produced them, prevented future invasion.

Another view regards immunity as dependent on an *acquired tolerance* of the poisonous products of any given pathogenic microbe.

Yet another, commonly known as the *Phagocytosis* theory of Metschnikoff, makes the white blood-cells (*phagocytes*), which undoubtedly do incorporate and probably destroy micro-organisms, the all-important agents in protecting the body against pathogenic bacteria.

At the present time a quite different explanation of the phenomenon of immunity is very generally accepted. Indeed, it rests upon such experimental and practical evidence as to leave little room for doubt as to its substantial correctness. This may be called the antitoxine theory. And since it is the basis of what I have to suggest as a possible means of treating tuberculosis, I may perhaps be permitted to enter into it a little more fully.

This theory teaches that in response to the presence of the poison (toxine) generated by a given microbe there is produced in the system a specific antidote (antitoxine) which neutralises and destroys that poison. How and why this toxin-neutralising substance is formed, remains for the present a mystery.

It must be remembered that this doctrine of *antitoxines* which, stated simply as an hypothesis, does not perhaps commend itself as having a *primâ facie* appearance of probability, has been established purely as the result of experimental investigations.

It is well known that animals differ greatly in their natural susceptibility to different bacterial diseases. In the case of anthrax, frogs, dogs, and white rats, amongst other animals, enjoy complete immunity. Mice, however, are very susceptible. It has been found by Ogata and Joshuara that the blood serum of these naturally immune animals has a very wonderful effect in protecting susceptible animals from the disease. A single drop of frog's blood, or half a drop of dog's blood injected into a mouse, suffices to save it from the effects of anthrax inoculation that would be otherwise fatal.

Results of a similar kind have been obtained by injecting the serum of animals *artificially* rendered immune (by inoculation, or by the injection of the toxic products of virulent cultures). Behring and Kitasato, in their well-known experiments upon tetanus and diphtheria, have shown that if the blood serum of an animal rendered immune to one of these diseases be mixed with a virulent culture it neutralises its pathogenic power so that it is no longer fatal to susceptible animals. They have also shown that the serum of an animal immunised against one or the other of these diseases is a therapeutic agent of the greatest practical value. For obvious reasons it has been more successful in the case of diphtheria than of tetanus, since the existence of the latter disease cannot be diagnosed till the occurrence of muscular spasms, which are in themselves evidence of profound poisoning; whereas in diphtheria the false membrane gives warning of the nature of the affection before any considerable quantity of the diphtheritic toxine has been absorbed. And in these early cases of diphtheria the treatment by antitoxic serum has been eminently successful. Every week the medical journals contain accounts of cases treated by this method with very encouraging results; and in the hands of Professor Roux in Paris and of Arnson at Berlin it has lowered the death-rate of all cases of true diphtheria to the extent of some 30 per cent.

Other investigators have established the fact that immunity may in like manner be produced to various other diseases by injecting into susceptible animals the filtered products (toxines) of the specific microbes, and that the blood serum of animals so treated is able to save others not so protected when inoculated with virulent cultures. Demonstrations of this kind have been made with respect to the *Diplococcus pneumoniæ*, the bacillus of hog cholera, and the *Vibrio Metschnikovi*.

It is particularly interesting to note that this antidote-producing power of the animal organism is not confined to the elaboration of *antitoxines* in response to the *toxines* of pathogenic bacteria; for it has been pointed out by Ehrlich that immunity may be produced against certain poisons derived directly from the vegetable kingdom, and that this immunity is dependent on the development of direct antidotes or substances capable of neutralising the poisons employed. *Abrin* and *ricin*, the poisonous principles respectively of the Jequirity and castor oil beans, are extremely active poisons; *ricin* being the more deadly of the two. Ehrlich estimates that one gramme (15½ grains) of this substance would suffice to kill 1,500,000 guinea-pigs. And a drop of either poison in very dilute solution (1 in 50—1 in 100) introduced into the eye of a mouse causes acute inflammation and speedy destruction of the organ. Yet if mice be fed for some weeks with minute but gradually increasing quantities of *abrin* or *ricin* they become so far immune to the poison employed that they are able to resist an injection of from 200 to 400 times the fatal dose for mice which have not undergone this immunising process. Moreover, the strongest possible solution of *abrin* or *ricin* is without effect upon the eye of the immunised animals. But, as in the case of bacterial toxines, immunity to one poison gives no protection against the other. An animal proof against *ricin* is susceptible as ever to the action of *abrin*, and *vice versâ*.

A very remarkable circumstance is that the milk of a mouse immunised to one of these poisons is found to confer a like immunity on young mice suckled with it. And the same phenomenon is observed in the young suckled by a mouse immuned to tetanus.

What a vision these latter facts seem to unfold! By some similar process it may be found possible to render our herds immune to tuberculosis, and their milk, instead of an ever-present danger, a potent means of fortifying delicate persons and children against that deadly scourge!

"How is it possible," as Professor Roux says, "to avoid devoting all our attention to these antitoxines, which appear to be scientific remedies for two of the most serious diseases so feebly combated by empyrical means until now?" And how, I would venture to add, is it possible to avoid turning a hopeful glance towards other terrible maladies, such as leprosy and tuberculosis, to see what promise these extraordinary revelations of serum therapeutics may hold for them also?

It may be objected *in limine* that diseases of the kind mentioned are intrinsically different from those that have been so successfully dealt with: from diphtheria and tetanus on the one hand, in which the toxines are absorbed from a local focus, but the bacilli themselves do not pervade the organism; and such diseases as anthrax, on the other hand, where the living bacilli themselves swarm in the blood and internal organs. But the very fact of the success of serum therapeutics in two such dissimilar conditions seems to warrant the hope of a like success in diseases which have points of resemblance to both.

In regard to tuberculosis, it is well known that there are great differences in susceptibility in different species of animals, and even amongst individuals of the same species, as is notorious in the case of mankind. On what do these differences depend? Probably, I would suggest, leaving out of consideration for the present possible differences in the phagocytic power of the amœboid and fixed cells, on the amount of toxine neutralising substance (tubercle antitoxine) present in the blood, or on, or combined with, capacity of the organism to generate such substance. The latter supposition seems to offer a clue to the benefit sometimes derived from Koch's tuberculine in incipient tuberculosis—*i.e.*, in cases where the organism is still capable of responding to the toxine tuberculine by an increased production of the antitoxic material.

If this be the true explanation of differences in susceptibility to tuberculosis, it would seem, judging by the analogy of the cases of tetanus and diphtheria, that if an animal having a high degree of natural resistance were repeatedly injected with the toxine of the tubercle bacillus it would tend to bring about a great development of the antitoxic or neutralising principle, and the serum of the animal so treated might perhaps be found of therapeutic value in the treatment of the disease. It is, however, open to question whether an animal having a strong natural resistance is necessarily capable of generating more of the antitoxic principle than one having a less natural resistance. *A priori* it would seem probable.

With a view of testing the validity of these ideas, I have lately made an experiment (on a very small scale), an outline of which may be of interest, not perhaps on account of any great value or conclusiveness of the experiment itself, but as an illustration of the kind of way in which, I venture to think, our present knowledge seems to lead us to look for a scientific method of combating tuberculosis.

Those who are acquainted with the conditions of bush life—particularly the bush life of North-western Queensland—will, I would fain hope, look leniently on the many shortcomings of the little piece of experimental work I have attempted in this direction.

Casting about for a suitable animal, it occurred to me that the goat enjoys a reputation for resistance to tubercular infection, and is moreover an animal easily available for experimental purposes. Accordingly, with a view of testing, in the first instance, the claims of the goat to resistance, I, in November, 1893, injected some tubercular sputum into the cellular tissue of the abdomen of two goats, each goat receiving about half an ounce. Three weeks later I repeated the operation, using on this occasion the sputum from a case of acute pulmonary and laryngeal phthisis, in which the bacilli were exceptionally abundant. The two goats thus doubly inoculated were kept for purposes of comparison with four others of the same size, sex, and age. Ulceration took place at the points of inoculation in both goats. The inguinal glands became much enlarged, but did not suppurate, and gradually subsided. Otherwise the goats appeared in no way affected. They remained, and remain at the present time, more than a year after the inoculations, as well and healthy as the four control animals kept with them. The average temperature of healthy goats was found to be a shade over 102 degrees Fahr. Of twenty-six observations on the inoculated goats the highest temperature recorded was 103 degrees Fahr., and the lowest 101·6 degrees Fahr. In May last (six months after the inoculations) ·01 cm. of Koch's tuberculine was injected on three several occasions into each of the inoculated goats, but on no occasion did any rise in temperature follow. From these facts I concluded that the goats' reputation for resistance to tuberculosis was not altogether without foundation, for the same kind of inoculations practised on susceptible animals—*e.g.*, guinea-pigs—almost invariably result in general infection, and death in a comparatively short time.

So much being established, I endeavoured to ascertain if by frequently injecting the toxine of the tubercle bacillus (in the shape of Koch's tuberculine) into a healthy goat I could so far bring about in its system such an increased development of the neutralising principle (tubercle antitoxine) as to make the serum sufficient as a curative agent when injected into animals suffering from tuberculosis.

To this end six adult male guinea-pigs were on the 22nd July, 1894, inoculated with sputum from a case of rather chronic phthisis, in which the specific bacilli were present in moderate numbers. The operation was repeated four days later, great care being taken to prevent the escape of any of the sputum. Three of these guinea-pigs were placed in one cage for experiment, and the remainder in a second cage for control. The difficulty of obtaining these animals was the reason for employing so small a number.

On 27th July a healthy goat was for the first time injected with ·01 of Koch's tuberculine. Thirty-six hours afterwards blood was taken from the jugular vein of this goat; and on the following day, when the serum had separated, 1 cm. of it was injected into the cellular tissue of the back of each of the three experimental guinea-pigs.

This process of injecting tuberculine into the goat, and subsequently injecting the goat's serum into the three experimental guinea-pigs, was repeated as under stated, it being understood that the bleeding of the goat was effected at varying periods from twenty-four to forty-eight hours or more after each injection of tuberculine.

Goat Injected with Tuberculine.		Experimental Guinea Pigs Injected with Goat's Serum.	
27th July ...	·01 cm.	29th July ...	·1 cm.
29th " ...	·01 "	3rd August...	·1 "
1st August...	·02 "	5th " ...	·1 "
3rd " ...	·1 "	10th " ...	·1 "
8th " ...	·1 "	14th " ...	·1 "
12th " ...	·2 "	20th " ...	·1 "
18th " ...	·2 "	27th " ...	·1 "
23rd " ...	·1 "	4th Sept. ...	·3 "
30th " ...	·1 "	17th " ...	·2 "
2nd Sept. ...	·1 "	26th " ...	·2 "
10th " ...	·1 "	13th October	·2 "
24th " ...	·1 "	19th " ...	·2 "
17th October	·1 "		

On 9th October one of the control guinea-pigs died, this being the seventy-ninth day from the first and seventy-third from the second inoculation. *Post-mortem* showed the usual signs of experimental tuberculosis—enormous infiltration of liver, spleen, and lymphatic glands with tubercular deposit.

On 18th October a second of the control guinea-pigs died. *Post-mortem* showed much the same condition as the first—enormous tubercular infiltration of liver, spleen, and lymphatic glands.

The weather had now become extremely hot, and the limited means at my disposal made it extremely difficult to obtain and preserve the goat's blood in a sterile condition during the separation of the serum, and to add any antiseptics would obviously vitiate the experiment. In spite of much care and the rejection of many tubes of serum, a contaminated specimen was accidentally employed at the last injection (on 19th October), resulting in the death of one of the experimental guinea-pigs two days later. At the *post-mortem* this guinea-pig presented a very marked contrast to the two control animals already referred to. It was fat and heavy. At the site of the last injection the cellular tissue was infiltrated with a quantity of dark sanguineo-serous fluid which was found in a cover-glass preparation to swarm with the *Bacillus septicæmiæ hæmorrhagicæ.* The liver, spleen, kidneys, lungs, and lymphatic glands were *perfectly free from any sign of tubercular deposit.*

The absolute freedom of this guinea-pig from tuberculosis seemed highly encouraging, especially in view of the fact that two out of the three control animals (untreated with serum injections) had already perished—a mass of generalised tuberculosis.

But the sequel was less satisfactory. It should be mentioned that on account of the accident to this guinea-pig, and the extreme difficulty of preserving the serum, the injections were now discontinued.

On 1st November one of the experimental guinea-pigs died of tuberculosis, the spleen being the organ chiefly affected.

On 20th November there remained one experimental and one control guinea-pig. Neither presented any external sign of illness. They were killed on this day, 122 days after the first inoculation with tubercular sputum. Both were found to have some tuberculous patches in the spleen; there was also a yellow caseous nodule in the liver of the control guinea-pig.

Thus of the three experimental guinea-pigs—*i.e.*, those treated by the serum injections—the results were—

No. 1. Free from tuberculosis on the 92nd day from the first inoculation with sputum.
No. 2. Died of tuberculosis on the 103rd day.
No. 3. Very slightly affected on the 122nd day.

Whilst of the untreated or control guinea-pigs—

No. 1. Died of tuberculosis on the 79th day.
No. 2. Died of tuberculosis on the 88th day.
No. 3. Very slightly affected on the 122nd day.

Is there any sign of promise in these results, meagre as they are? Personally I am sanguine enough to fancy that there is.

In the first place two of the three untreated animals died sooner, and were more generally affected, than any that received the serum injections. Moreover, in spite of accidents, mistakes, and various difficulties, the absolute duration of life was somewhat greater in the treated than in the untreated animals; whereas, if there was no intrinsic benefit in the serum employed, the frequent repetition of the slight operation of injection, with the incident disturbance and manipulation, should have told somewhat against it.

The number of animals employed was, however, obviously too small to permit of any definite conclusions. But I venture to hope that someone whose environment is more favourable to such inquiries may be induced to repeat the experiment on a larger scale. And I would venture to suggest that very much larger quantities of the serum should be injected, and that the injections should be continued over a much longer time; also, as a further control of the method, that a third set of tuberculous guinea-pigs should be treated with the serum of goats which had not been subjected to injections of tuberculine.

After the foregoing paper had been prepared, and its title submitted to the hon. secretary of this section, an article reached me (by Dr. Arthur Gamgee, in the *Lancet* of 6th October) entitled "Dr. Viguenat's Treatment of Tuberculosis," from which it appears that Dr. Viguenat, of Moudon, Switzerland, has been working on very similar principles, but in place of goat's serum has employed that of the ass, whose natural insusceptibility he has sought to enfore by subcutaneous and intravenous injections of virulent cultures of tubercle bacilli. Dr. Viguenat claims to have successfully treated cases of human tuberculosis by his method. But, as Dr. Gamgee and a leader-writer in the *Lancet* point out, Dr. Viguenat has not published the experimental data on which he basis his claims, nor details of the cases he has treated, so that we must, I think, as yet, consider the serum treatment of tuberculosis as one of promise rather than of fulfilment.

4.—A SANATORIUM FOR THE TREATMENT OF CONSUMPTION IN QUEENSLAND.

By EUGEN HIRSCHFELD, M.D., Hon. Bacteriologist to the Brisbane Hospital

It has been first shown by Dr. Brehmer, of Goerbersdorf, in Prussia, that a great number of patients suffering from consumption in its early stages can be cured if they are placed under favourable conditions, while in many cases by appropriate treatment life can be prolonged with a "fair share of capacity for work and for enjoyment." When we consider how great the number of patients is who are suffering from phthisis, it is strange indeed that the subject has received comparatively but little attention. Of course, it is absurd to expect that full health will be restored in those cases in which great portions of one or both lungs have been destroyed by the progress of the disease. To stop a further encroachment on the still healthy parts of the lung is all that we can hope for in those patients. But the prognosis would have been very much more favourable if the patient had come earlier under suitable treatment.

The conditions necessary for a successful treatment of consumption are—

1. Early diagnosis.
2. Early treatment.
3. Treatment in sanatoria specially set apart for consumptive patients.

The first two conditions I need hardly further dilate upon. The smaller the portion of the lung affected by phthisis, the more favourable the prognosis. The treatment of consumption in a special sanatorium in Queensland forms the subject of this paper.

There can be very little doubt about the experience that general hospitals, as a rule, are quite unsuitable for the reception of consumptive patients; in the first instance, on account of the risk of infection with tuberculosis to which the other patients of the same institution are exposed, more particularly when they are convalescent from other debilitating diseases, which have left them in a condition specially predisposed to contract consumption. Quite apart from this consideration, the depressing influence of surroundings in a hospital on patients who are suffering from a disease which, as a rule, does not render the confinement to bed necessary, the lack of home comforts, the enforced idleness, which gives the patient plenty of opportunity to meditate and brood over his disease, the general, I need not say unfounded, dislike and distrust of hospitals amongst the public; all these aspects, though insignificant, perhaps, when taken singly, become of serious importance in a disease the successful treatment of which is only achieved by the observance of details. We all know how great attention has to be paid to the proper feeding of the consumptive patient. The plain food and plain cooking are eminently suitable for the majority of the inmates of a general hospital, but the delicate stomach and capricious appetite of a phthisical patient have to be reckoned with if we want to see him put on flesh. Moreover, the quantity of food required would present financial difficulties. The expenditure for milk and eggs, for instance, would form a very big item. Fruit is another article which might be objected to by the committee if it were introduced into the general hospital fare, though it is desirable to vary the monotony of the daily food to stimulate the lack of appetite of the consumptive. All these things, as I shall explain later on, can be obtained easily in a country sanatorium which grows them itself, and thus to a certain extent can be made self-supporting. There is yet another consideration which renders city hospitals unsuitable for the reception of people suffering from tuberculosis of the lungs. The hospital of a large town must be and is usually built in close convenience to the city, and is destined mostly for acute affections which require confinement to bed. The space is naturally limited, and not at all sufficient for patients who require plenty of fresh air, which they are able to obtain in a sanatorium.

I have dwelt more fully on the disadvantages connected with a city hospital in the treatment of consumption because some little time ago it was suggested to set apart the Diamantina Orphanage in Brisbane as a special institution for tuberculous patients. If this idea were carried into effect the improvement, as far as the consumptive inmates are concerned, would be very small.

The institution of sanatoria is one of modern times. Dr. Herman Brehmer, of Goerbersdorf, in Prussian Silesia, was the first who, after having proved in his "Doctor-Dissertation" in 1856 the curability of tuberculosis of the lungs, suggested a sanatorium under suitable climatic conditions as the most favourable place for successful treatment. After great initial difficulties—the very idea of the curability of phthisis excited at the time a great amount of distrust—he succeeded in carrying his ideas into effect, and the sanatorium was started in 1859. The number of patients that came to it in the first year was very discouraging, but the splendid results obtained with those subjecting themselves to the treatment were not slow in making proselytes for the sanatorium of Dr. Brehmer. The attendance rose by leaps and bounds in the following years:—1860, 60; 1862, 104; 1869, 318; 1873, 706; and the indisputable fact that more than 10,000 patients suffering from consumption of the lungs have been given back to full health and full work, apart from those that have been relieved and improved by the treatment in the sanatorium of Goerbersdorf since its inception, makes it our duty to record Dr. Brehmer's name as one of the great benefactors of humanity. Since that time numbers of sanatoria have arisen in all parts of Germany, Europe, and Northern America, which, however, are nearly all conducted on the same or similar principles as Dr. Brehmer's original institution.

A sanatorium for consumptive patients in Queensland should be different from the European institutions, because we have to deal in Australia with climatic conditions vastly different from those in middle Europe. We enjoy here a climate which allows, or rather enforces, an out-door existence nearly the whole year through. This is a great advantage in our favour. The idea of great and expensive central buildings, which is rendered necessary at home for the purpose of protecting the patients against the inclemencies of the weather during winter time, can be abandoned. The formation of parks, drives, walks, promenades, colonnades, as they abound in Goerbersdorf, Falkenstein, Favos, and other places, is no doubt very beautiful, but too expensive to be thought of if we want to have a sanatorium here in Queensland, where there is not the same number of rich people as flock from all parts of the world to those renowned institutions. But, as I hope to be able to prove to you, all these particulars, though advantageous at home, are out of place and unnecessary in Queensland. My suggestion is, that we should not have a sanatorium as described above, but a sanatorium farm. A piece of land of about 1,000 or 2,000 acres should be set apart at a distance of about five miles from a railway town which is in convenient communication with the big centres of population in Australia. I mention the distance of five miles from the town because it is not desirable that there be too frequent communication between the patients of the sanatorium, who should be under strict discipline, and the inhabitants of the town. At least I noticed that too close communication between the inmates of the sanatorium and the town proved a great nuisance in Goerbersdorf. There are always some who, when they are supposed to be walking or driving, go down into the smoking-rooms of the hotel to drink beer and play cards, often for hours together. Happy in the consciousness of having successfully deceived their doctor, they come home and demoralise some of their friends until, the cough getting worse, they have to give up, for some time at least, their clandestine excursions. At the same time the above-mentioned distance of five miles is not too great to allow a speedy communication when it is wanted; especially when patients arrive, they are frequently not in a condition to stand long drives in going out to the sanatorium. The whole place should be sheltered against the prevailing, especially westerly, wind, either by scrub and forest or by selecting a site at the slope of a hill. It would be very desirable to plant pine trees as soon as the formation of the sanatorium has been undertaken. The houses should be built on a specially protected place on the selection where plenty of shade trees abound. The houses should not contain more than four or six rooms, a single bedroom for each patient, one of the six rooms to be the parlour, the rest all bedrooms. They are to be built of wood, stand on piles about 5 feet high, and be surrounded by a veranda about 10 or 12 feet wide. The patients have only to sleep indoors. They should take their meals even on the veranda, which will be protected at least on two sides even when it rains. Each of the houses has to be provided with good bathing accommodation.

In the centre of the establishment the house of the medical director is situated, who should have the whole management of the place, both the medical and administrative part. The patients, as soon as they arrive, are divided into two classes—those who are able to get about, and those who are confined to their beds. The latter class will be very small, and consist of persons who are affected with pneumonic tuberculous processes, high fever, hæmorrhage, or other untoward complications. Every patient who is able to get about is told off to do some work according to the strength he possesses, as he is ordered by the medical director. This, in my opinion, forms a very important factor in the whole scheme, for the following reasons:—

In the first instance, men who have been used to a busy occupation, and who are not sick enough to lay up, would not stand the *ennui* of a lazy life for any length of time. The great majority of the consumptive patients have not had any physical out-door occupation, or otherwise they very likely would never have become affected with consumption. Their muscles have mostly atrophied. The small atrophic heart of the consumptive we are so familiar with in the *post-mortem* examinations of cases of tuberculosis has not been called upon for a long time to sustain any more than the minimum circulation which is required for the body while at rest; the lungs in consequence have not been ventilated sufficiently, and the stagnation of air and the growth of tubercle bacilli are favoured in these parts of the lungs which partake least in the respiratory excursions of the thorax. The effect of physical out-door work, commensurate to his strength, as prescribed by the medical director (I should like to emphasise on this occasion that I am by no means inclined to recommend heroic remedies like physical over-exertions) is an extremely favourable one on the constitution of the consumptive patients; the muscles of the body become firmer, the heart and circulation improve alike, both inspirations and expirations become deeper; stagnating secretion, swarming with tubercle bacilli, is expectorated, assisted by the increasing strength of the heart and the respiratory muscles (m. intercostales, sternomastoid, rectus, pectoralis major, &c.). The patients should be employed in ordinary farm work—for above everything this improves their appetite—ploughing, fencing, digging up trees, or gardening, &c. It is quite necessary for the success of the undertaking that the medical director and his assistants should have supreme command of the place, so that he be able to enforce strict discipline amongst the patients, and to punish offenders eventually with expulsion. Every patient should go out riding every day for at least two hours; those who have not been in the habit of riding will have to learn it. Lawn tennis, cricket, and other games serve to vary the monotony of the daily routine. The hot hours of the summer day can be spent by the patient lying under shady trees, either reading or sleeping or chatting with other patients. The daily tasks set to the patients are increased with the increasing strength in the same ratio. An especial feature of the plan is the formation of an orchard. As regards women, light gardening work, gymnastic exercises, lawn tennis, riding, driving, &c., will have to be allotted to them. The arrangement as proposed above has a double advantage. While on the one side it is eminently calculated to improve the health of the consumptive patient, it lessens on the other side the cost of maintenance very considerably. Nearly the whole daily bill of fare can be produced on the farm—meat, milk, butter, eggs, vegetables, all kinds of fruit, all of which it would be very expensive to purchase. It would thus be possible to make the place almost self-supporting. How considerable the saving effected by it would be, anybody familiar with hospital management will see at once. Even wine, which is indispensable in the treatment of consumption, could be made on the premises.

The whole management of the sanatorium should be vested in the medical director, who is to have absolute command over his patients. He examines every person that is admitted to the institution, and maps out the daily routine for him, as described above. Special attention has to be given to the diet, since over-feeding is the most important factor in the successful treatment of the consumptive. The diet has to be regulated according to the principles laid down by the recent researches of Voit, Pettenkofer, F. Hirschfeld, and von Noorden. Another important point, which must not be neglected, is the regulation of dress and the daily bath, which both tend to place the skin of the consumptive patient under the most advantageous conditions.

Simple regard to these two things is quite sufficient to do away, in almost all cases, with night-sweats. At least I have not met with a case in my private practice since residing in Queensland in which careful attention to the functions of the skin has not sufficed to remove this annoying and dreaded symptom. I have not been compelled, so far, to use any medicine in any one case to suppress the night-sweats. The medical director should have some experience of laryngoscopy, bacteriology, and microscopy. The nursing staff need only be small, since nurses are required but for the small number of patients who, on account of untoward complications, are temporarily confined to their beds. The duration of residence necessary in early cases to effect a cure will average from six weeks to six months. In very few instances will a longer residence be required.

The site to be chosen for the sanatorium should possess the following climatic qualities:—(1) Dry atmosphere; (2) great number of sunny days; (3) freeness from dust; (4) shelter against the prevailing winds. Finally, let us not forget to pay attention to the soil on which the sanatorium is to be erected. Pure, dry, and porous soil should be selected, with an efficient drainage.

However, all these conditions are of very great importance, and require to be dealt with in separate papers.

I cannot do better than conclude with the beautiful and true words of Dr. Herman Weber, in his Croonian lectures:—"There is nothing more baneful than the idea that phthisis is incurable. It shuts out all honest attempt to do everything possible, and bring every sacrifice to promote arrest and cure. I well remember, from my student's time, when phthisis was considered almost incurable, how the name of the disease was withheld from patients, how depressed they became when they found it out, how they regarded themselves as doomed, and sometimes killed themselves by poison or debauchery. I remember also the joy amongst the younger medical generation and the public when a more hopeful view developed itself, and the readiness to submit to every sacrifice and to long expatriation, with a fair chance of recovery. . . . . The portions of lung which are already destroyed before the treatment has commenced cannot be restored, but experience has shown to us that life, with a fair capacity for work and for enjoyment, can be maintained after the loss of a good part of the lung, and that the remaining part, if sound, can be rendered capable of doing the ordinary life work of both entire lungs."

5.—THE INTERCOMMUNICABILITY AND PREVALENCE OF HUMAN AND ANIMAL TUBERCULOSIS.

By S. S. CAMERON, M.R.C.V.S., Melbourne Veterinary College.

At a meeting such as this, composed of scientists who are more or less acquainted with the generalities and detail of the subjects that are being brought forward for discussion, and whose object it is to initiate and obtain a more systematic and practical application in everyday life of ascertained scientific facts, it appears to me that the best results will be obtained by directing attention mainly to the way in which beneficial use can be made of the knowledge and information already at our command. Especially is this the case in regard to the disease tuberculosis, for it is beyond doubt that the measures in force all over the world, and particularly throughout the Australian colonies, for the prevention of the disease both in man and animals are not nearly commensurate with the scientific knowledge we possess whereby means are indicated for its better prevention.

I shall direct your attention first of all to the evidence we have at present of the transmissibility of the disease from man to man, from man to animals, from animals to animals of the same and of different species, and from animals to man.

That tuberculosis is communicated from one human being to another largely and mainly by inhalation is established. It is equally well established, both by chemical observation and experiments, that it is communicable from man to animals—to wit, to guinea-pigs, rabbits, fowls, &c.—by ingestion, inoculation, or inhalation of sputum of phthisical patients, or water in which the handkerchiefs and linen of phthisical patients have been washed.* It is the established creed of animal pathologists, and is incontrovertible, that the disease is readily communicable from one animal to another of the same species—from cow to cow by cohabitation and inhalation, from cow to calf by ingestion of milk, from pig to pig by ingestion. There is also abundant evidence available, which it is unnecessary to detail, by which is clearly manifested the transmission of the disease from one animal to others of different species. I will relate two of a number of cases furnishing such evidence with which I have been personally connected; one in which pigs and calves were infected by means of milk from a diseased cow, and the other in which pigs were infected by the ingestion of tuberculous cow's flesh, and both of which, I venture to think, will furnish important links in the chain of evidence establishing the intercommunicability of the disease.

In the first case, nine young pigs, five weeks old, were fed from a trough three times a day for a period of three weeks with the milk of a tuberculous cow. This was not done experimentally, but for economical reasons—the owner, a North of England farmer, preferring to use the milk in that way rather than to destroy the cow at once. The cow was affected with generalised tuberculosis, including tubercular mammitis; in fact, on *post-mortem* examination, the tubercular lesions found to exist were as extensive as any I have seen. At eight weeks old four of the pigs were sold in open market, and lost sight of. Four others were sold to a neighbouring benevolent institution; and one, a sow pig, was kept on the farm for breeding purposes. I will just deal with the subsequent history of this sow pig. When about three months old a debilitating diarrhœa set in, and, in spite of suitable attention, food, and housing, it became more or less chronic. As time went on she exhibited very little growth, and did not thrive. She gradually developed into a veritable "piner," and, having exhibited early a sexual desire, she was put to the boar, with the object of promoting a thriving tendency; but the improvement in condition and growth which had been expected did not occur. She conceived, however, and farrowed a week before her time, the litter consisting of four dead pigs and one living one which died during the day. I missed the opportunity of seeing these young pigs, and so could not determine whether they were congenitally diseased or whether their

* M. Guinard, Lyon Medical, 17th May, 1891.

deaths were due to the maternal cachexia. The sow gradually grew sour-tempered, had a husky dry cough, and, when bustled about the stye, respiratory distress was very marked. An attempt was made to fatten her; and, although she did scant justice to the process, there was improvement sufficient to effect her sale at auction. She was secured by a local butcher, and I was present when she was slaughtered. The intestinal and mesenteric lymphatics were principally affected with characteristic tubercular lesions, but the lungs were also extensively diseased—the pleural membrane, both costal diaphragmatic and pulmonary, being, in the words of the slaughterman, "one mass of grapes."

While being able to observe minutely the manifestation of disease in the young sow pig just referred to, I had the privilege of access at will to the four pigs of the same litter located at the district workhouse piggeries. The condition and progress of the whole of them was almost exactly parallel with that of the one I have just described. They had intermittent diarrhœa, did not grow to any size, and an attempt to get them ready for the Easter market as young porkers totally failed. They were kept on till the end of the summer; and every means to improve their growth and condition failing, they were sold to a "slink" butcher, who, after keeping them for a little while and failing to freshen them up, had them slaughtered and their carcasses disposed of in a way known only to himself. In confidential conversation with this man some time afterwards he stated that while he kept them they had chronic diarrhœa and a wheezy cough, and he described to me the appearance of the internal organs after slaughter. He described the lungs as having cheesy masses in their substance, the ribs and skirting (diaphragm) as being "graped," and the net of the bowels or mesentery as being studded with grey nodules and tumours of varying size—appearances which to the naked eye are characteristic of tuberculosis, and which were identical with those of the first pig I described.

If anything further were needed to confirm or intensify the conviction that these pigs contracted the disease by imbibing the milk of the tuberculous cow, I would mention that they were of the sow's second litter. Her first litter was healthy, throve, and grew well and strong, and none of the pigs from it that were retained on the farm ever showed the least sign of being diseased. The sow herself was healthy, well grown, and lusty. She reared third and fourth litters by the same boar, which were uniformly free from unthriftiness or taint of disease; and when she was fattened and slaughtered all the organs and tissues were found to be quite normal.

At the time the young pigs were being fed on the tuberculous milk seven heifer calves also received a portion of it along with milk from other cows twice daily. Two of these were sold and lost sight of, but the remaining five all died of tuberculosis during from three to twelve months afterwards, *post-mortem* examination revealing extensive intestinal and pulmonary tubercular lesions. In this case, too, the negative evidence afforded by older and younger calves points directly to the milk of this particular cow as being the only means of infection, for older calves which were being fed on skimmed milk from other cows at the time these seven were having the infected milk, and younger calves born after the slaughter of this diseased cow, grew up healthy and strong, and showed no signs whatever of tuberculosis.

The second series of cases, demonstrating infection of pigs by ingestion of tubercular cow's flesh, occurred in Australia. Unfortunately it is a common practice at abattoirs and boiling-down establishments to feed pigs on refuse offal and the flesh of diseased animals, most often raw. Even some inspectors of stock are in the habit of allowing the diseased flesh, organs, &c., of animals they have condemned to be fed to abattoir pigs, destined shortly to become human food. A disgusting practice surely!

It was at one of these places that the cases occurred. A varying number of pigs were kept; but at the time of my connection with the affair there were twelve pigs left out of a total of twenty-three, eleven having died during the previous three weeks. The carcasses of five most recently dead were exhumed and examined. They all showed tuberculous abcesses and swellings in the parotid and pharyngeal regions, the tonsils in two cases containing caseated masses. In two of the pigs the mesenteric lymphatic glands were enlarged, and in one of these both the prepectoral and bronchial lymphatics were enlarged and congested, but in no case was there any pulmonary lesion. The twelve pigs still living were slaughtered at my suggestion, and seven of them were found to be tuberculous. One had a pharyngeal abscess, the whole seven had intestinal tuberculosis, and one had grey masses in the lung tissue. So that in all twelve pigs out of the seventeen I examined were tubercular, and it is reasonable to deduce that, out of the total of twenty-three, eighteen (the whole eleven that died and seven found to be diseased when killed) were tubercular. I had some difficulty, for reasons that will be obvious to any who have had to do with the inspection and condemning of cattle, in ascertaining the history of these pigs. So far as I could reliably discover, however, about two months previously three cows in the last stages of tuberculosis had been killed at intervals of four or five days, and the pigs had been fed on their flesh and offal. The internal organs had been thrown in for them to rummage amongst and eat raw, and the flesh had been cooked before being given to them. Previous to this, and also during the time intervening between this and the fatalities, the pigs were regularly fed on the raw offal of the abattoirs indiscriminately, whether normal or diseased.

Regarding the communicability of tuberculosis from animals to man, all eminent medical and veterinary pathologists now unreservedly agree that infection of man from animals does occur. Koch (Berlin), Chauveau and Nocard (Paris), Bang (Copenhagen), Burdon-Sanderson, Sims-Woodhead, McFadyean, and Fleming (London), Arloing (Lyons), Perroncito (Turin), Ostertag (Stuttgart), Bollinger (Münich), and others have at different times during the last five years announced their conviction to this effect. The labours of the Paris Congress on Tuberculosis, held in July and August, 1891, settled definitely that the bacilli causing human and animal tuberculosis are identical; that each will produce similar tubercular lesions in any susceptible animal; and that any difference in the lesion produced (in man and cows respectively, for example) depends upon the modifying influence or histological variation of the host, and not upon any morphological or functional difference in the bacilli.

The main source of human infection from animals is the milk of tuberculous cows. The flesh of tuberculous animals may be a less frequent source of infection. But at present doubt exists as to what extent tuberculosis in man depends on these sources of infection. In considering this question, with the object of arriving at a reasonable conclusion on the point, a number of circumstances have to be reflected on. It will have been noted that in the cases of transmission from cows to pigs which I have just reported, the infection occurred by ingestion, and the predominant lesions were in the intestines or mesenteric lympathic glands. In those cases in which lesions existed in other organs (with the exception of the tonsilar and pharyngeal lesions) they were evidently secondary to mesenteric invasion. This is a point of paramount interest when it is remembered that intestinal or mesenteric tuberculosis as a primary affection in the human being is almost wholly confined to children under five years old, whose sole aliment during a considerable portion of their existence has been milk. The deduction to be drawn from the analogy is that the method of infection in infants is by ingestion. I am glad that this phase of the subject has been so authoritatively ventilated recently by Dr. Sims-Woodhead, a pathologist who has always been to the front in the investigation of the relationship of human and animal diseases. At the International Hygienic Congress, in London, he reported that of 127 cases of tuberculosis in children there were 100 cases in the mesenteric glands, apparently primary—*i.e.*, 79 per cent. In only twenty of these 100 cases had abdominal tuberculosis been diagnosed. Again, in an address delivered before the North London Medico-Chirurgical Society, 18th October, 1894, he says: "It cannot be too strongly insisted upon—and I am sure that those of you who have made any considerable number of *post-mortem* examinations of the bodies of tuberculous patients who have succumbed at various periods of life will agree with me in this—that the affection of the lung often appears to be (although the ultimate cause of death) merely a secondary affection. I have seen in case after case of children, and in animals fed on tuberculous material, the lungs markedly affected, but in a large proportion of these cases it has been possible to trace the course of invasion back from a caseous or old calcareous mesenteric gland through the chain of retroperitoneal glands, up through the diaphragm to the posterior mediastinal and bronchial glands, and so on to the lung. I have not seen this in a few cases only, but in dozens of children, in a few adults, and in many animals. . . . The importance of the bearing of these facts is evident when it is considered that in all probability tuberculosis of the alimentary tract and of the mesenteric glands can be brought about only by the introduction of tuberculous material, usually milk in the case of children."

Connecting these statements with my own experience in the disease in pigs, I would point out, in order that the importance of the cases I have recorded should not be minimised, that of all domestic animals the pig most nearly approaches the human being in anatomical and histological structure, and in pathological processes—*i.e.*, the reaction to pathogenic agents. They are alike omnivorous. The stomach, intestines, and epidermal appendages are remarkably alike. The quantity and distribution of lymphoid tissue in the alimentary canal of the pig (tonsils, Peyer's patches, &c.) are very similar to those in man. The pig is the only animal in which there is a tendency to intestinal ulceration similar in character and situation to that seen in man in typhoid fever.

In connection with the frequency of the intestinal affection in young children, I wish to refer to a matter that I think has not been sufficiently taken into consideration by European authorities. I mean the extreme degree of mortality in young children in large cities and centres of industry in the old world. In one town in Lancashire, in which there are large flax and jute works employing mainly women and boys, the mortality in children under five years during the year 1886 was 55 per cent. of the total deaths in the borough. This seemingly enormous infantile death-rate was increased the following year (1887), during which 30 per cent. of the total deaths were in children under one year. Considering that in these large towns a great number of the children of the poorer population must inevitably be fed by the bottle on cow's milk when their mothers are out at work for the greater portion of the day—and considering, too, that bovine tuberculosis is infinitely more common in city dairies than in extra-urban ones—would it not be well that more attention should be directed to this phase of the question, with the object of ascertaining whether a larger proportion of these infant deaths than is now suspected is due to a tubercular milk supply?

There are two other difficulties in the way of ascertaining to what extent tuberculous milk is a source of infection in the human being that I wish to refer to specially. The first is that, except in somewhat rare instances, there are no means of ascertaining, except by *post-mortem* examination, the exact nature of the many fatal cases of infantile diarrhœa met with in medical practice—of deciding whether they are of tubercular or non-tubercular origin, so that in private practice a lot of what might be valuable evidence on the subject is lost. Another difficulty is the present lack of means whereby a medical man might trace the infection in a case of acquired intestinal tuberculosis to what may be its proper source—namely, the milk of an affected cow. In the present condition of legislation and public health administration touching the inspection of dairy cattle he would have to pursue his quest single-handed, and in his attempt to indicate the identical animal would probably be at fault so often that the search would be unfruitful. In parenthesis I am tempted to speculate how different this would be if he could at any time consult with and obtain information as to infected dairies and cattle from a veterinary official, whose regular duties and intimate acquaintance with all possible foci for the distribution of the disease would enable him to allay or endorse the suspicion. At present a medical man can only suspect infection from a dairy, but he has not the means at hand to prove the correctness of his suspicions, and without this proof he will not be believed. Veterinary surgeons, too, are alike handicapped in any endeavour to afford proof of the danger to children of infected milk. In everyday practice they frequently encounter cows suffering from tubercular mammitis, the milk from which is mixed with that of others and distributed for family use, but, except in very rare instances, they have not the opportunity for observing its effect. In short, there is no connecting link between what the medical man sees and suspects and what the veterinary surgeon sees and suspects. In the absence of this, proof is out of the question; the perhaps well-founded suspicions of each cannot be either confirmed or disproved.

Although, as the law at present stands in all countries, it is impossible to prove the actual transmission from cattle to man experimentally, and although, as I have indicated, there are great difficulties in the way of ascertaining exactly the source of infection in any given case of acquired intestinal tuberculosis in a child, still there are scattered throughout medical and veterinary literature records of numbers of cases which, to the reasonable and scientific mind, leave no room whatever to doubt that the source of infection was cow's milk. I will quote one of these reported by M. Auguste Olliver at a meeting of the Académie de Médicine, 24th February, 1891:—"Two months previously he had been called in to a girl aged twenty who was suffering from tubercular meningitis. Her parents were both robust, and she herself had had no previous illness to speak of, and lived under excellent hygienic conditions. She died from coma on 26th December, 1890. The girl had been educated at a convent in Chatres, where within a few years tuberculosis had attacked twelve persons, five of whom had died. It appeared that on 26th November, 1889, the veterinary inspector had condemned the flesh of a cow between nine and ten years old which had been slaughtered that morning in the Chatres abattoir. The animal seemed to be in good condition, but there were tubercles in the lungs, peritoneum, and paunch, while the udder was completely stuffed with them. This cow had belonged to the convent where the patient had been educated, and its milk had for nine years been consumed by the pupils and others in the house. Between October, 1887, and the date of the slaughter of the cow one of the pupils died of tuberculous peritonitis, one of general tuberculosis commencing in the mesenteric glands, and three of pulmonary phthisis. Another pupil developed tubercular disease of the elbow, and six others showed evident signs of tubercle of the lungs, but, on being removed from school and kept considerable periods in the country, recovered. In none of these cases was there any family history of tubercle."

Another case equally convincing is one of which I have personal knowledge, but which has not up to the present been published. The victim was a child fifteen months old. For some time previous to its death it was being attended by a medical man of my acquaintance for chronic diarrhœa, marasmus, &c. During his connection with the case it was ascertained that the child had been fed from a bottle with cow's milk almost from its birth, on account of the poverty of its parents. The mother having to go to work every day at a local factory, the child was left, except at dinner hour and in the evenings, in charge of a neighbour. The cow's milk was secured from a general dealer who lived near and kept two cows. Both these cows were intensely tuberculous, and were destroyed by order of the veterinary inspector two months before the child died. Both showed generalised tuberculosis in an advanced stage, one having extensive long-standing tubercular mammitis. No *post-mortem* examination of the child was made on account of the objection of the parents. But, having regard to the history of the case, its probable causation, the fact that there was no family taint, and the symptoms and character of the affection throughout, the medical man in attendance had no hesitation in coming to the conclusion that the child had died from "intestinal tuberculosis," and the case was reported to the borough medical officer as such.

Again, I have recently been furnished with the details of a case which occurred in the Taranaki district, in New Zealand. On an arable farm on which only a few cows were kept, the milk of one particular cow was used for a number of years for family use. This cow ultimately developed tuberculosis and was destroyed, well-marked tuberculosis of the udder being manifested. One of the sons was in the habit of drinking milk largely as a beverage. He was not particularly robust, but there was no previous history of tubercle in the family. After being ill, debilitated, and subject to attacks of persistent diarrhœa for some time, symptoms of nephritis supervened. The patient was removed to Wellington, and there operated upon. The affected kidney was removed, the lesion being tuberculous nephritis. For a time considerable improvement in the general health resulted. Ultimately pulmonary tuberculosis developed, and at the end of about three years from the onset of the disease the patient died. Having regard to the history of this case, the sequence of intestinal, renal, and pulmonary tuberculosis, the medical men in attendance were firmly convinced that the source of infection was the diseased cow's milk, which the patient had drunk in large quantities.

It will be noticed that in the three cases I have detailed, the cows from which the infective milk was derived were affected with mammary tuberculosis. And this might lead to the conclusion that milk is infective only when there is disease of the udder. Such, however, is by no means certain. In fact, the experiments of Bollinger* point to a directly opposite conclusion. He produced tuberculosis in animals by the ingestion and inoculation of the milk of tuberculous cows in which the udder was healthy. This milk proved virulent in 55 per cent. of cases. He also proved the specific virulence of the milk in a lesser degree when there was only localised tuberculosis in some organ remote from the udder. He concluded that leucocytes most probably conveyed the virus either in the form of bacilli or spores to the udder. That leucocytes do absorb and carry micro-organisms, including the tubercle bacillus, is now generally accepted, the fact being commented on and put to practical use by Dr. Sims-Woodhead in his recent elaborate explanation of the channels of infection in tuberculosis, especially in regard to invasion of the mesenteric lymphatic glands, when infection results from ingestion in children and pigs. On the other hand it must be pointed out that the experiments of Dr. Bang, Chief Veterinary Surgeon to the Danish Government, an authority equally eminent and reliable, are not so conclusive on this point as those of Bollinger would appear to be. He found that the milk of only two out of twenty-eight tuberculous cows with healthy udders proved infectious—*i.e.*, 7 per cent. against Bollinger's 55 per cent.

Unfortunately the microscope furnishes no material aid towards determining whether milk is infective or not. The *Bacillus tuberculosis* is very difficult to discover in milk from an udder extensively diseased, and even when it is known to be highly infective.

To sum up, then, it may be definitely stated that experiments, investigations, and practical observations all render palpable the danger to a susceptible subject of the use of milk from a cow with

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* *Lancet*, September, 1890.

generalised tuberculosis, or one in which there is tubercular affection of the udder; and the necessity for total prohibition of the sale or use of such milk and the immediate slaughter of the animal is generally recognised. There is still a little uncertainty, however, as to whether the milk may be infective in cases of localised tuberculosis, and in which the udder is apparently healthy. Still, in view of the many positive results obtained by the experimental feeding of animals with the milk of cows in which no udder lesion could be detected, it cannot be asserted that the milk is devoid of danger. Assuming that the active infective agent is never present in the milk except the tuberculosis has become general, the extreme difficulty of ascertaining clinically the exact time when a local affection becomes generalised, and the impossibility in some cases of detecting tubercular mammitis except on very careful *post-mortem* examination, warrants the adoption of measures in all cases equally stringent and as much calculated to conserve public health as in cases where no doubt exists of the disease being general.

PREVALENCE OF THE DISEASE.

If the evidence which I have presented to you, and such other evidence as we have at our command, is sufficient to be convincing of danger of infection of man by transmission from animals (as I think it is), the degree of danger will depend greatly on the extent to which the disease exists in animals furnishing food materials for man, and it is necessary, therefore, to indicate, so far as is possible, the prevalence of the disease in these animals. In this paper, however, I shall confine myself to a consideration of the prevalence of the disease in cattle, as although it exists to a considerable extent in pigs and to a limited extent in sheep, the danger to be apprehended from these sources is infinitesimal compared with that from bovines.

Unfortunately there is a dearth of reliable statistics having reference to the question of prevalence. Such as there are, however, prove it to be a very common disease in cattle in all countries of the world. It is only during the last few years that any systematic attempt has been made to ascertain the prevalence of the disease by rigid inspection of dairy stock and of slaughtered animals, and in those countries in which this is being done it will be a year or two before exact estimates can be formed. By that time, too, the aid furnished by the results of the use of the tuberculin test will be available. In the meantime such estimates as can be got from reliable statistics at present at command will have to be depended on. For instance, in Great Britain, since the coming into force of the Pleuro-pneumonia Compulsory Slaughter Order, valuable data have been obtained. Under that Order all cattle affected with pleuro-pneumonia, all those that had been in contact with affected cattle, and all cattle on any farm on which the disease broke out were slaughtered, and the veterinary inspectors were instructed to note to what extent tuberculosis prevailed in the animals. The results in some counties—as recorded in the 1892 report of the Veterinary Department of the Board of Agriculture—were startling. In London 25 per cent. of all the animals slaughtered under the Order were tuberculous (in one herd fourteen out of twenty cows, and in several herds 30 and 40 per cent.), in Yorkshire 22·8 per cent., in Midlothian 20 per cent., in

Durham 18·7 per cent., in Edinburgh 5·75 per cent. Of the 20 per cent. found in Midlothian, 16 per cent. were cows and heifers in calf, 1 per cent. bulls, 2 per cent. were store stock over one year old, and 1 per cent. store stock under one year. Professor McFadyean estimates that at least 5 per cent. of all adult cattle in Great Britain are tuberculous, and that the proportion in milch cows kept in cities is probably 20 per cent., and these estimates are endorsed by other eminent veterinarians.

In other European countries the statistics furnished by abattoir authorities vary remarkably in different provinces—as low as 1·6 tuberculous cattle per thousand in Bavaria in 1887, and as high as 60 and 70 per cent. at Hildesheim. The variation in these statistics is evidently due to the amount of care with which the animals are inspected, and also to the fact that many veterinary inspectors do not record cases in which the disease is very limited. It is manifest that the proportion of cases found in abattoirs increases with the care taken for their discovery. Thus at Dresden in 1888 there were only 2 per cent., and in 1889 3·2 per cent., of tuberculous cattle reported, but since then the number of veterinary inspectors has been considerably augmented, and the proportion had risen in 1892 to 14·4 per cent. Again at Bromberg, since inspection has been carried out by veterinary surgeons, the percentage of tuberculous animals slaughtered reaches as high as 26·2 per cent. In Denmark and Saxony inspections are very thorough, and the proportion of tuberculous cattle is 16 per cent. in the former country and 22 per cent. in the latter. In the Berlin abattoirs for 1891 there were 12 per cent. of bovines found to be affected, and throughout Prussia 6·3 per cent. In France the proportion of carcasses condemned as unfit for human consumption is small—less than 1 per cent.; but it is to be noted that it is only those animals in which the tuberculosis is generalised and all the organs invaded that are seized.

Regarding the proportion of cases of generalised tuberculosis to those in which the disease is localised, there is a valuable record published by the *Revue Scientific* of statistics obtained at the Leipsic abattoirs. Of 13,688 cases of the disease in cattle found there, 13·8 per cent. were generalised.

Coming now to the prevalence of the disease in the cattle of the Australian colonies, I am at a great disadvantage, for there are at present no means of ascertaining authentically the extent to which it exists. I have, however, no hesitation in saying that it is as common in these colonies as in any part of the world, and I wish to take this opportunity to publicly correct a false impression that obtains in some quarters to the effect that cattle kept in a semi-wild state in the Australian bush are immune to the disease. Knowing that tuberculosis is to a certain extent a disease of domestication, spreading readily by close cohabitation, a superficial consideration would seem to support such an impression. But careful inquiry and experience of the conditions under which the cattle are bred and reared show that there are factors obtaining in Australia which predispose to the prevalence of the disease just as much as do the close cohabitation and pampered treatment of cattle in byres in the old world. First of all there is an equal vulnerability to the disease inherited, here as in England, from pure-bred and diseased sires and dams, either imported or the progeny of imported stock. Then, although for the most part cattle are never housed, they always, even when in large mobs, have favourite camping-grounds on which they congregate at night, and which become contaminated with infected droppings and discharges. The stagnant waterholes in the vicinity of these camping-grounds may at any time become contaminated, and facilitate the spread of the disease. A third factor in the spread of the disease in the past has been the indiscriminate way in which virus has been obtained to inoculate for the prevention of pleuro-pneumonia. Tuberculous animals are very likely to become affected with pleuro-pneumonia, and stockowners (thousands of whom inoculate their own cattle) in many cases are as likely to obtain virus from a tuberculous animal as not. Most important of all, however, is the fact that at least 90 per cent. of all the cattle bred in Australia are not slaughtered until they have arrived at or gone far beyond maturity. The females are kept for breeding until eight and nine years old. Bullocks are not slaughtered until at least four years old, the average age being six. When it is remembered that tuberculosis in bovines is mostly a disease of maturity or old age, it will be seen that the opportunities for its spread are very great, as each animal that becomes affected as age increases acts as a fresh centre from which the disease is communicated. Abattoir statistics endorse this, as it is found that the disease is most common by far in bullocks especially those from Queensland —up to seven, eight, and nine years old, and in old dairy cows.

In Victoria, I am sorry to say, any statistics which are obtainable in reference to the disease in dairy and store stock are altogether unreliable. Mr. Pentland, Chief Inspector of Stock, furnished me with an estimate of the prevalence of tuberculosis in Victorian stock, based evidently on the proportion between the numbers condemned annually by the stock inspectors and the number of cattle in the colony. He put it at 1 in 300, or ·3 per cent. This, in view of abattoir statistics and the experience of myself and other veterinarians in private practice, I believe to be an absurdly low estimate; and the utter unreliability of the figures is easily explained when it is mentioned that the stock inspectors are laymen without training in scientific diagnosis, and in some cases lacking in anything more than two or three years' experience of animal diseases. Again, it is evident that only a small proportion of the cattle of Victoria can be inspected by them annually, there being only six district inspectors in the whole colony.

At the Melbourne city abattoirs the animals are subject to lay inspection on slaughter, and during the existence of the Board of Inquiry on Tuberculosis in Cattle in Victoria some fairly reliable statistics were obtained. On these the board based the statement that "probably, therefore, over 7 per cent. of all cattle slaughtered for the meat supply of Melbourne are tuberculous in some degree." For the half-year ended December, 1884, of 16,780 cattled slaughtered, 7·1 per cent. were affected, and for the half-year ended June, 1885, of 18,722 slaughtered, 4·1 per cent. were affected, or an average for the year of 5·6 per cent. Of the total number slaughtered for the year, however—viz., 35,502—only 113 were condemned as being unfit for human food, or a proportion of 1 in 314. It will be instructive to compare these figures with the returns for the six months ended

August, 1894, which have been furnished to me through the courtesy of Mr. John Clayton, Town Clerk of Melbourne. These show only the number slaughtered and the number condemned, no record having been kept latterly of the number affected. Of 17,681 cattle slaughtered, 169 were condemned as unfit for consumption on account of tuberculosis. This is a proportion of 1 in 104·6, so that the number warranting seizure now is exactly three-fold the number in 1885. The inspection is still a lay inspection, and, assuming it to be equally rigorous with that in 1885, this points to a considerable increase in the number affected—an increase up to 16·8 per cent., in fact—and I would not deny that such an increase has taken place. Mr. John Robertson, the inspector at the abattoirs, however, estimates the proportion affected to be between 7 and 10 per cent. It must be borne in mind that only the better class of cattle are sent to these abattoirs, all the "piners" and beasts suspected by their owners as likely to be condemned being sent to private slaughter-houses, of which there are about twenty in Melbourne and suburbs, and at which there is no supervision or inspection for disease at all.

Turning to dairy stock, it has long been known—and the fact receives confirmation by the Midlothian statistics I have quoted—that the proportion of tuberculosis in milch cows is much greater than in other classes of stock. In these, too, the tendency to generalisation is most marked. If we take a very low estimate then, say, 7 per cent., of tuberculosis in dairy cows, and if we assume that danger of infection of man only exists when there is generalisation, then, taking the Leipsic statistics as a standard (viz., that of every 100 cases of tuberculosis 13·8 per cent. are generalised), we arrive at the somewhat alarming fact that 1 in every 100 dairy cows can convey and is conveying tubercle infection to susceptible human beings in our midst. I ask myself, "Is this known or believed?" I cannot answer. I should be sorry indeed to think that, if it were known to those in whose hands the conservation of the health of human beings is placed, they should be so neglectful of their trust. Conversely I ask myself, "Can it be denied?" and I confidently answer, "No." Surely, if it is true, some steps should be taken to minimise the danger. I am afraid no very satisfactory answer could be given to the question, "What is being done by medical scientists to ascertain all the etiological factors in the increasing prevalence of this dire scourge of humanity?" With typhoid care has been taken to ascertain the sources of infection reliably, and to counteract that infection. So with scarlatina, small-pox, &c.; but with tuberculosis—a disease responsible for 14 per cent. of the whole of the human deaths recorded from all sources of disease—a disease affecting all mammals and many other classes to such an extent as to be considered a likely factor in the ultimate extermination of species—what appears to be a certain source of infection is totally neglected, and no adequate attempt is made to ascertain how such human tuberculosis is attributable to this source.

My eminent friend, Dr. Springthorpe, the president of this section, suggested to me that I should indicate to you the measures at present in force in Australia for minimising the dangers of infection from animals. I am sorry indeed that this is beyond my power, for I find that in most colonies nothing of the kind is being attempted.

New South Wales is the bright exception, however. Recently in that colony, mainly I believe through the instrumentality of my friend, Mr. Edward Stanley, F.R.C.V.S., ably seconded in his efforts by the Public Health Department, there has been instituted a system of rigorous supervision of all the dairy cattle and of all the metropolitan meat supply by skilled veterinary surgeons—a system which even in its infancy has demonstrated its usefulness, and which in the fulness of time bids fair to considerably enhance the health and national wealth of the colony. In the other colonies, so far as I can gather, and certainly in Victoria, little is being done in this direction.

Dr. Gresswell, chairman of the Victorian Board of Public Health, ever since his arrival in the colony has been foremost in advocacy of reform in connection with the supervision of animal food supplies and animal diseases transmissible to man, and the growing feeling of danger to be apprehended from these sources which is now appreciable in Victoria is mainly due to his persistence. Up to the present however, his efforts in this direction have met with little encouragement or support.

The Australian Health Society has been instrumental in advising the public of the danger of infection by cow's milk, and has suggested that all milk should be boiled before being used. I question the expediency of depending on the public adopting this suggestion. If we do so depend, I am afraid we are hugging a delusion. In fact, I object to recommending the boiling of milk as a panacea for the risk of infection. It is beginning at the wrong end, and is like supplying sewage water to a community with a recommendation that it be boiled before use. The fact is, milk is and will be consumed in immense quantities unboiled. It is impossible to enjoin the boiling of milk with everybody. However it may be pressed it will not be carried out. Further, may it not be fairly claimed that the State ought to take steps to protect the public from the imposition upon it of unwholesome or infected milk; that, in fact, the public have a right to demand that when they purchase what purports to be wholesome milk, that article of food should not have mixed with it the virulent germs of a deadly disease. The State recognises its incumbency to protect the public against the mere adulteration of milk and other articles of food, but makes no adequate arrangement for the performance of a much more manifest and urgent duty—namely, to see that these are not actually disease-producing.

It will be expected that I should offer some suggestions for the better control of dairies and the suppression of this disease in dairy cattle, with the object of minimising danger to mankind, for it will have been gleaned that I apprehend vastly more danger from uncontrolled dairies and milk supply than from uncontrolled abattoirs and meat supply. It is obvious that if affected animals were systematically destroyed there would be so many less centres of infection. The prevalence of the disease in animals would be decreased, and a corresponding decrease of danger to man would follow. Whether the disease in bovines can be completely eradicated or not is a problem which will shortly be submitted to proof. The Danish Government have set aside £25,000 to be used by Dr. Bang, V.S., for the purpose of ascertaining the possibility of stamping out the disease in cattle in that country. The aid of tuberculin and careful, patient physical examination by capable veterinary officers will be brought to bear in the inspections. The trial will extend over five years; and if during or at the end of that time sufficient success attends it as to warrant its continuance, further funds will be devoted to a rigorous and close system of control and inspection of all cattle in the country, and slaughter of diseased ones. Whatever may be the result (personally I am of opinion the attempt will fail), the Danish authorities are to be heartily commended for their enterprise, and statistics and information of great value to other countries will be forthcoming, so that the progress of the trial will be watched with intense interest by animal pathologists on all sides.

I think, however, that the first concern of pathologists is to discover the extent to which the infection of man occurs from animals. So far as infection by cow's milk is concerned, I think this could be done comparatively easily and without much expense. I would suggest, in the first place, that all dairy farms or milk-producing places on the one hand, and all milk-shops or milk-selling places on the other, should be licensed or registered, and a license fee paid. Before a license is granted to any dairyman his herd should be carefully examined by a veterinary inspector, and all healthy cattle branded with some distinctive mark on the hoof or horn, and only the milk of such cattle should be allowed to pass into consumption. The veterinary inspection should be repeated at short intervals—a month, say—and all diseased or doubtful animals destroyed or removed from the dairy herd. No fresh cows should be used for dairy purposes until after inspection. A complete record should be kept by the veterinary inspector of all pronounced and suspected cases of disease, and of all isolations and slaughterings. Then, if a record were kept of the milk-shops to which the milk of any given dairy was supplied, and at which it was retailed, it would be a comparatively easy matter for any medical man to trace the milk supply in any case of infantile tuberculosis. Having ascertained the milk-shop from which the family was supplied, he could, by referring to the veterinary inspector's records, form a fairly reliable estimate whether the source of infection had been the milk supply.

Such a plan could be tried at first in a limited area in each colony—in the metropolis and its suburbs. By its operation for a year or two, if medical men in practice took advantage of it and recorded their deductions, we should be enabled to more correctly and practically gauge the danger which exists, and the prevalence of the disease in bovines, than can possibly be done at present. And on the experience so gained we should be able to suggest reforms in the control of the milk supply which would be better calculated to practically deal with the trouble than any that could be suggested now, based as they would be on reliable data. I think that when such data are procured they will amply and eloquently prove that the estimate of the degree of danger that, in this paper, I have stated I believe to now exist, is not exaggerated; that, in fact, it is, if anything, below the mark. It will then remain for the public to insist on a remedy or attempted remedial measures, and it will *then* be gross negligence on the part of those whose concern it is to conserve public health if they are in the least laggardly in their efforts to bring about the necessary reform.

6.—CONTAGIOUSNESS OF TUBERCULOSIS.

By Dr. F. H. VIVIAN VOSS, F.R.C.S., Eng., &c.

The first remark I can remember hearing in relation to medicine and the medical profession was that by an old man to the effect that consumption was a standing reproach to the medical profession, and would be so as long as it continued such an unchecked scourge to mankind. Since then (nearly twenty-five years ago) steady advance has been made. We know much of the cause and origin of tuberculosis, though by no means all. The great discovery that the tubercles or foci of the disease contained a virus or poison capable of producing the malady when inoculated into the lower animals was made by Klencke and Villemin.*

Later Burdon Sanderson, Klebs, and others repeated and confirmed their experiments; but it is now, I think, universally admitted that the *causa causans* is the tubercle bacillus discovered by Koch in 1882, and he was so exact in his original papers that, Von Ziemssen says, it was found that all the criticism and investigation which followed his solution of the problem not only made no essential change but no important addition to his statements. Every link in the chain of evidence was firm.

The human *Bacillus tuberculosis* is a rod-shaped microbe, in length rather less than the diameter of a human red blood corpuscle. When stained and very highly magnified the bacillus presents a dotted appearance, showing that the protoplasm forming its body is interrupted. It is not proved so far that either the stained granules or the bright spaces are spores, as has been stated by various observers. That the tubercle bacilli contain spores is proved by certain experiments of drying and heating; but what the character of these spores is, and how they appear in the bacilli, has not been satisfactorily shown. In bovine tubercular matter the bacilli are, as a rule, shorter and thinner than those found in human tubercular matter, and the division of the protoplasm is not so general and uniform. But these minute differences need mean nothing more than differences due to the different soils on which the bacilli were raised. Such morphological differences are well known to occur in other instances if the microbe be cultivated in different soils. When the tubercle bacilli obtained from any source, bovine or human tuberculosis, or from artificially infected animals, are passed through the rabbit or the guinea-pig, in these animals the new crop of bacilli all appear to be morphologically the same. I quote the foregoing from Klein's recent essay on the "Pathology of Infectious Diseases," which is quite the opposite view of what he formerly published in his book, "Micro-organisms and Disease," wherein he writes: "I cannot for a moment accept the statement that the bacilli are identical in the two diseases, human and bovine tuberculosis." This change of opinion in such an eminent authority is very valuable and well worth noticing.

Tuberculosis is a term covering many diseases, apparently different diseases. It may perhaps best be defined as that disease which is casually related to the operation of the tubercle bacillus. It

* Etude sur la Tuberculose, Paris, 1865.

occurs in the human subject in a variety of different forms, the most notable of which are: Acute general tuberculosis, tubercular phthisis, tubercular meningitis, tubercular pleurisy and peritonitis, tabes mesenterica, scrofula or strumous disease, lupus; but it may affect any organ or tissue of the body. In cattle it is known as pining, wasting, the grapes, or grape disease (perlsucht).

The clinical differences between these diseases are so great that, except as being due to the action of the tubercle bacilli, it would be very difficult to associate them. These differences may be due on the one hand to the bacilli, on the other to the characteristics of the host or person affected. The bacilli may be functionally different, may vary in virulence and activity, as they have or have not developed in a congenial soil; they may infect in large or small numbers the host, whose tissues no doubt vary in resistance in different degrees at different times—(Klein). Whatever may be the causes of these differences, the point is the recognition of the fact that all are due to the one cause—viz., the *Bacillus tuberculosis*.

The importance of the disease is indicated by the terrible mortality. Hirsch estimates that among civilised communities the average deaths from phthisis (consumption) amount to one-seventh of the total mortality, and it must be remembered that this does not by any means include all the deaths which are due to tuberculosis; and then in addition we must think of the many painful, disfiguring, and crippling affections that tuberculosis produces, which, while not causing actual death, entail much suffering.

In England and Wales, in 1840, the death-rate of phthisis was nearly 4,000 in every 1,000,000 persons living. In the last five years it has declined to 1,635.

In Queensland in 1892 the number of deaths from tubercular diseases was 601 out of a total mortality of 5,266, which is more than one-eighth and less than one-ninth (11·41 per cent.). In 1893 there were 670 deaths by tubercular diseases out of a total of 5,695 (476 phthisis), between one-eighth and one-ninth, or 11·77 per cent. Taking 300 deaths which have occurred under my immediate notice, 43 deaths were due to tubercular disease, which is almost exactly one-seventh (14·33 per cent.):—Phthisis, 38; tabes mes., 2; acute tubercular meningitis, 2; other forms, 1; total 43. Hirschberger estimates that 25 per cent. of all deaths occurring in children under one year of age are due to tuberculosis. To put these in another form, it has been found by calculation from the death reports in the United States that during every hour throughout day and night 14 persons die of consumption alone.

I beg to submit that tuberculosis is a communicable disease; that it is a contagious disease, and therefore a preventable disease. I think we should thoroughly realise this fact. We have become for this disease like men in battle who, constantly seeing their comrades dropping in the ranks, become almost indifferent—the everyday occurrence is unnoticed. I do not think it is necessary to enter into any evidence to support my statement that tuberculosis is a communicable disease. It has been so clearly demonstrated by experimental and clinical evidence that it is now accepted by all authorities and, I think, the medical profession generally.

Consumption is preventable. This should be the cry all over the land. For many years it was held that consumption was inherited, in which belief it was but natural to stand by and take no precautions to prevent the spread of the disease. We now know that the disease is not inherited. As a rule, with very few exceptions, the bacillus itself does not pass from parents to offspring before birth.* The inheritance bequeathed from consumptive parents is the marked tendency to contract the disease when exposed to the exciting cause. When the parents are affected with tuberculosis the children from the earliest moments of life are exposed to the disease, under the most favourable conditions for its transmission; for not only is the dust of the house very likely to contain bacilli, but the close and intimate relations between parents and children, especially mother and baby, are particularly favourable for transmission of the disease by direct contact. The frequent occurrence of several cases of tuberculosis in a family is explainable not by the supposition that the disease has been inherited before birth, but because it has been acquired since, and probably from the parents.

The parasite—the *Bacillus tuberculosis*—is present wherever there is tubercular disease; it is found in all tissues in which tubercular disease is active. The expectoration and other secretions of the air-passages in all persons and animals whose lungs, throats, mouths, or nostrils are the sites of tubercular disease, practically speaking, always contain tubercle bacilli. In tubercular kidney disease the urine may contain tubercle bacilli; the bowel discharges when tubercular ulceration of the intestines is present; the discharges from tubercular abscesses, bone disease, &c.

Cornet has shown by his experiments that in the rooms where consumptives live tubercle bacilli are frequently present in the dust on the walls, floors, and furniture. He practically found no tubercle bacilli in the dust of the rooms of those consumptives who carefully spat only into spittoons, and not on to the floor or into handkerchiefs.

By the experiments of Dr. Ransome, reported in a paper read before the Royal Society, and by the experiments of others, it appears that the breath of a consumptive very rarely, if ever, contains tubercle bacilli, but during coughing, by the chance scattering of mucus, tubercle bacilli may be ejected, and so become a source of danger to persons around.

From animals to man contagion is spread chiefly through cow's milk, and by eating the flesh of tubercular animals. Bollinger and Hirschberger, in Europe, and Ernst, of Boston, U.S. America, have found that the milk of cows affected with pleural or pulmonary tuberculosis can infect guinea-pigs even when the udders are perfectly normal, and the cows themselves are in a very good state of nutrition. When the udders themselves are the seat of tubercle, the milk is then infective in a very high degree. It is very important to appreciate this evidence, for it means that it is never safe to use for food the flesh or milk of an animal suffering from even localised tuberculosis. The explanation may be that tubercle bacilli are circulating in the blood—*i.e.*, the virus is becoming disseminated through the general

* Hiller, at the Copenhagen Congress, 1884, reported having observed one congenital case in the human subject. In the case of animals several instances have been recorded of the transmission of tubercle from the cow to her calf before birth.

blood circulation—or it may be that the spores are present in the milk, though not the bacilli, and this would account for the infectiousness of milk in cases where no bacilli could be found.

Numerous experiments by a considerable number of observers have established on a firm basis a very generally held belief that the flesh of animals suffering from tubercular disease does convey infection to healthy animals, including man. Meat from tubercular animals, thoroughly cooked or roasted, has always given negative results when used experimentally; partially cooked or underdone meat when used has frequently been followed by tuberculosis. If the milk has been boiled for five minutes it loses its infectiousness altogether. Bollinger has also shown that the milk from the healthy udders of tubercular cows loses its infectiousness after dilution—1 to 40 or 1 to 100. He advises the mixing of milk from different animals, and cautions against the consumption of milk taken from any particular cow. Von Ziemssen says: "Of course the risk from this source is very much lessened on account of the custom of mixing up the milk," &c. Klein says: "It is contrary to what one would *à priori* have expected—viz., one would have thought it better not to mix, in order to avoid possible contamination of normal milk."

To boil meat, plunge for a few minutes into boiling water to coagulate the surface and prevent escape of the juices. Afterwards keep in water at 160 degrees to 170 degrees. To kill *T. bacilli*, the temperature must be kept at 158 degrees Fahr. (70 degrees C.) for at least one hour.

Fowls by eating tubercular sputum have been known to become tubercular; and a healthy, robust woman by eating the half-cooked flesh of sixteen of these fowls in the course of four months became consumptive. I know of a case in which a consumptive lady went to stay on a station, and used to spit on to the ground near the veranda. The ducks about were seen at times to devour this sputum—the ducks, previously healthy, soon all died of tuberculosis.

Numerous cases have been reported in medical journals in which tuberculosis, localised or general, has followed inoculation or introduction subcutaneously of tubercular matter by means of a cut, scratch, or sore.

We have, therefore, four means by which the disease may be introduced into the body, viz.:—(1) Inhalation into the air-passages and lungs; (2) swallowing into the alimentary canal; (3) direct introduction by inoculation; (4) heredity. By considering these with our other knowledge we may arrive at a conclusion as to what are the best methods to adopt to prevent the spread of the disease.

We have in this disease a striking example of the old proverb that "prevention is better than cure," for I regret to say that there is at present no known cure except in the few cases of localised disease, occurring chiefly in man, which can be dealt with surgically by excision, and so removing the focus. Medical treatment can be of very great assistance in many cases by arresting the disease, and so practically curing as far as the individual is concerned. Exactly speaking, however, these cases are not cures; the focus is still present, and the disease may, under favouring conditions, break out afresh at any time.

In considering preventive measures, we must remember that the disease may pass from man to animals or from animals to man, and then chiefly by the ingestion of tubercular diseased meat or milk. The disease may also pass from one to another in case of both man and animals. In the case of animals preventive measures must be in the direction of improved hygiene of dairies and cattle-sheds, especially in attention to ventilation, good feeding, pure water, and, last but not least, cleanliness. There should be isolation of all suspected animals, and thorough disinfection of stalls, buildings, or railway trucks in which tubercular cattle have been. In the case of valuable animals, as stud cattle, which are suspected of being tuberculous, the injection of tuberculin might easily settle an uncertain diagnosis. I do not think this method is generally applicable, but it is available. It should be remembered -(1) That cases in which tubercle bacilli have actually been discovered have, after the injection of even a larger dose than recommended by Koch, shown no general or local reaction; (2) cases of quite healthy persons have shown general reaction after injection of a very small dose (less than 0·01 gramme). Precautions should be taken that the flesh or milk of diseased animals should not be used as food for man or animals. All such meat or milk should be condemned and destroyed. All diseased animals should be slaughtered and the carcasses destroyed, compensation being given to the owner. Breeding from tubercular diseased animals should certainly be prevented by law.

To carry out these measures it would be necessary to have increased legislation, and to appoint medical officers of health and sanitary inspectors. At present in Queensland almost the whole inspection of slaughter-yards is in the hands of police constables, and their duties chiefly or entirely consist in the registration of the list of brands of slaughtered animals which is supplied to them by the butchers.

It has long been a matter of suspicion in my mind as to whether the inoculation of cattle for pleuro-pneumonia was not a fruitful source of the spread of tuberculosis. The more I inquire the more confirmation my suspicion receives of its correctness. I will give two examples. An intelligent and fairly educated man has pointed out to me a tuberculous beast as a fine case to obtain virus from for inoculation of pleuro-pneumonia. This man, of course, did not know the beast was tubercular; but when I told him he did not appear to understand the difference. He had first-class recommendations as to competency amongst cattle, and was spoken of as being "well-up in the inoculation of cattle for pleuro."

A certain prominent scientific gentleman may, perhaps, himself relate here how he made a mistake by collecting serum as virus for the inoculation of pleuro-pneumonia, and how subsequent results and fuller examination showed the disease from which the animal had suffered was tuberculosis and not pleuro-pneumonia.

At a very large cattle market and slaughter-yard the following is gravely given me as an infallible test between a tuberculous and pleuro-pneumonic beast:—"Tie up the beast and suddenly strike it a full blow with the fist on the side over the middle of the seventh rib; then listen with a stethoscope—if you have not one, a tin tube will do. If a rough crepitating sound is heard, the case is one of tuberculosis; if only a sighing sound, it is a case of pleuro-pneumonia." It is not possible always to distinguish these diseases without microscopic examinations, and I think it is very clear some check should be put on this so-called "pleuro-inoculation." Competent judges should be satisfied the case is one of pleuro-pneumonia before any virus obtained may be used for inoculation.

In America, England, and other places active steps are now being taken to prevent the spread of tuberculosis amongst human beings. In the United States most of the health departments are actively circulating pamphlets to all medical practitioners and amongst the people generally, setting forth that—

Firstly.—Tuberculosis is a communicable disease, and is distinctly preventable.

Secondly.—It is acquired by direct transmission of the tubercle bacilli from the sick to the healthy, usually by means of the dried and pulverised sputum floating in the air as dust, and that the discharges from the lungs of tubercular patients are dangerous not only to others but also to the patient afflicted.

Thirdly.—The disease can be largely prevented by simple and easily applied measures of cleanliness and disinfection, and by segregation of persons suffering from the disease.

Hospital authorities are urged to make provision for the separation of persons suffering from pulmonary consumption from those persons affected with other diseases; that separate wards and special hospitals be provided for the exclusive treatment of this disease, and, as far as possible, all persons suffering from consumption be transferred to these hospitals.

By the New York Board of Health it is required that physicians and other persons, and the authorities of all institutions, forward to the Health Department the name, address, age, and sex of every consumptive person coming under their observation within seven days of such time; and, on receipt of this notice, the medical sanitary inspectors detailed for the work visit the premises in all cases (unless otherwise ordered), distribute circulars, and instruct the consumptive and family as to the measures to be taken to prevent the spread of the disease, and, if required, give such advice and directions as shall seem necessary for the cleansing or renovation of the apartments to render it free from infectious material.

In the case of death or removal, written directions are given as to disinfection; and a notice is posted on the door of the apartment, stating that consumption is a communicable disease, that the room has been occupied by a consumptive and is an infected place, and that it must not be occupied by persons other than those already residing there until the directions for disinfection have been complied with. The notice may not be removed until after disinfection has been satisfactorily carried out.

In the house patients should always expectorate into spittoons containing a suitable disinfectant. A convenient formula is corrosive sublimate, one drachm; hydrochloric acid, two ounces; blue coloured water, one gallon. In the street an expectoration flask should be used. The mouth should be wiped with bits of rags or Japanese paper, and these burned as soon as possible, before the expectoration has had time to dry. If a handkerchief is used it should be put in boiling water or strong disinfectant before the expectoration can dry and be shaken off.

Consumptives should sleep alone, certainly in a separate bed, and best in a separate room.

Another matter for consideration is the travelling of consumptives on steamers. I am sure thorough disinfection of all berths and cabins used by such passengers should be rigidly enforced.

It was suggested that the paper should have special reference to bovine tuberculosis. I think others will give you information in this respect much more valuable; and I am also of opinion that the really important aspect of the question is the human tuberculosis, for it appears to me much more harm and contagion spreads from man to man than from animal to man. I am subject to your correction, but, if I am right in this view, I think and hope this little paper of mine will not be without good if it helps to further ventilate the subject of necessary measures to prevent the spread of tuberculosis between human beings.

7.—COMPULSORY NOTIFICATION OF INFECTIOUS DISEASES.

By WILTON LOVE, M.B.

The health of a community is the most important factor towards the well-being of that community at large and of the individual units composing it.

To the various governing bodies and to the medical profession is entrusted the preservation of the public health—the former by their enactments instituting and enforcing the various means which experience and science have shown to be best adapted to that end; the latter in its dual preventive and remedial capacity.

Marked as have been the strides of the healing art during the past quarter of a century, the growth in importance of sanitary science or preventive medicine has been hardly less marked, and must inevitably expand almost indefinitely as the importance of the subject becomes so completely recognised as to compel recognition from those to whose hands legislative powers have been entrusted.

The Registrar-General for Great Britain shows how sanitary science and preventive medicine, working hand in hand with increased knowledge of disease and its successful treatment, have reduced the death-rate.

In the latter half of the last century, from what imperfect records exist, we estimate that the death-rate of London must have been at least 70 per 1,000 per annum—an appalling figure to us nowadays. The death-rate of London in 1838 was 23·5. The death-rate from 1838-70 was 22·4, an average on a continual decrease during that period. The mortality for the decade 1871-80 was 21·7, which is lower than in any preceding decennium since civil registration began. This diminuendo scale has also been maintained in the years following 1880—*e.g.*, in 1883 it was 19·5; 1884, 19·6; 1886, 19; or an average mean death-rate of 19·3 for the first half of the last decade. To put it in another way: The old Norwich life table, based on the mortality of 1838-1854, gave the mean expectation of life for males 39·6, for females

41·85 years; while a life table based on the mortality of 1871-1880 gives the mean expectation of life for males 41·35, for females 44·62 years—an increase of 1·44 years for males and 2·77 for females.

The registration of births and deaths is recognised to be of very high value in many ways, but from a practical point of view it is surely more useful to the community at large that they should be made aware of a threatening epidemic in their midst, and that the necessary steps be taken to strangle it in its infancy.

It is of more immediate importance to the individual that he should know that typhoid is being disseminated from a particular dairy or through the medium of a water supply than that he should know the mortality of typhoid during any given period. The knowledge of the existence of an infectious disease naturally implies the necessary means for isolation and prevention of its spread. This advantage, with others, I shall hope to show may be in a great measure secured by the adoption of a rational system of notification. The subject is one which even now demands attention in these Australian colonies. The spread of sanitary science will no longer allow us to say of every case of typhoid and diphtheria, "Kismet! it is the will of Allah"; for that is practically the attitude of the community and, I fear, of many of the medical profession at present.

I propose to consider the following points:—(1.) Is a system of notification necessary? (2.) If so, what are the best means of securing it? (3.) What are the results which have accrued from such notification?

I would here premise that what is meant by compulsory notification is the "immediate notification to the sanitary authority of the occurrence of a case of infectious disease, a penalty being attached for neglect of such timely notification."

The diseases usually included are the seven zymotics: Cholera, smallpox, typhus, typhoid, diphtheria, scarlet fever, and measles; while erysipelas, whooping-cough, relapsing and puerperal fever are occasionally included. Leprosy in the Australian colonies is generally included. In some quarters it has been seriously urged that phthisis should be included.

To proceed to the first point for consideration—Is compulsory notification necessary?

If an epidemic break out in a community, the more densely populated that community is the greater the number of cases and the higher the gross mortality. This is a lesson which has been learned by experience in the large cities of Europe, America, and Great Britain; and the adoption of compulsory notification is fast becoming universal. In Great Britain it has been optional for sanitary authorities to adopt the Compulsory Notification Act (1889), but steps are now being taken to enforce the inclusion of those few sanitary corporations which do not recognise it (*vide* B.M.J., 16-12-93, foot-note p. 1332). The question may be asked, "Is it so necessary in Australia—population is nowhere so dense as in the cities of the old world, and epidemics are not nearly so rife?"

I will reply in the words of Dr. Verco, in his inaugural address at the Adelaide Intercolonial Medical Congress:—"Coming, as our enterprising forefathers did, a three or four months' voyage over a disinfecting sea, they left many of the terrible scourges of humanity behind. The plagues of the olden time and of the new are largely only names and phantoms among us. Hydrophobia, the sweating sickness, relapsing fever, typhus, and cholera have never from their shrivelled lips breathed pestilence and death over our fair land. Now and again a foul form is seen prowling at our doors; the people are anxiously uneasy at the threatening danger, but hitherto the monster has been strangled on our threshold. I ask, Is not the heritage we enjoy in our freedom from these plagues a special boon? Does it not involve in common prudence a special duty, a special vigilance? And since our communication with the old world has become more rapid —and hence the liability to the importation of infection increased— and our intercommunication is more effective and more speedy, and hence the distribution of infection greatly facilitated—is there not special need for concerted intercolonial action, for discussion amongst ourselves of such subjects as federal quarantine," and compulsory notification? "And how is this emphasised by the virulence and wildfire spread which characterises infectious diseases in tropical and sub-tropical regions, and still more by the fact that it is in the domain of preventive medicine that the grandest victories of late years have been gained; and if I can read the times aright, it is in the department of preventive medicine that the largest, if not the most brilliant, triumphs will yet be won."

In Queensland during the past five years we have had visitations of scarlet fever and measles, as well as several outbursts of influenza; and to these with other miasmatic diseases are attributed during the first four years of the present decade no less than 1,766 deaths or over 8 per cent. of the total death-rate. In the Brisbane district during the same period there have been 411 deaths, or nearly 12 per cent. of the total death-rate.

Again, of the Queensland total of 1,766, 1,192 of these deaths occurred in children under ten years of age, a proportion of 68 per cent.; while in the more thickly populated Brisbane district 316 out of the total 411 deaths were those of children under ten, a proportion of 77 per cent. Consequently the children, in addition to the very heavy mortality of teething, diarrhœa, and dietetic troubles, have to be further saddled with the heavy mortality of epidemic disease—a serious thing for a young colony which depends so largely on its rising generations. Moreover, we must take into account not only the direct mortality but also the indirect mortality arising from subsequent disease.

The zymotic diseases have been called the preventable diseases; and if that is so, surely every effort should be used to prevent their introduction, or, if introduced, to prevent their spread. If compulsory notification can aid in any way towards this desired end, let it be used to the fullest extent. *Salus populi suprema lex.*

The early discovery of infectious disease to a local authority is like the early notification of a fire at a fire station, whereby a conflagration which might otherwise lay a city in ashes can be prevented if the warning be sufficiently timely. "A spark is a molecule of matter that may kindle a world."

The necessity for notification proved, we must next consider the best means of securing it. Various experiments as to voluntary notification have resulted in total failure, as might be expected, for nothing short of a complete return would be of avail, and this could only be secured by State compulsion; thus, in 1883 only 113 out of 300 practitioners in a large town in England voluntarily notified. The voluntary system answers very well in the case of cholera, because, the alarm is so great that it is practically compulsory, or, in other words, that result is effected by fear which is denied by reason. But in the case of a disease of which there is no fear—*e.g.*, scarlet fever, though it is a thousand times more destructive to life—the voluntary system breaks down altogether. Instead of the medical man reporting every case of preventable disease, he reports only such as he chooses. He will report, for instance, the case of a domestic servant whose presence in a large and respectable family is considered objectionable, and whose removal is therefore to be desired, and she is removed to the hospital accordingly; but the next case he may for special but insufficient reasons omit to notify, although the danger to the public may be as great in the one case as in the other.

Hence notification to be of any real value must not be optional, but imperative. Again, it must be immediate. In Birmingham where the optional system is in vogue, the health officer reports that he frequently receives notification of zymotic diseases after the medical man has been in attendance for weeks, and sometimes after the death of the patient, although there is a fee of 5s. attached to each notification. To expect efficient—that is to say, complete—notification by voluntary means is to ignore all past experience.

The one great objection to notification comes from those who hold that the adage "an Englishman's house is his castle" overrides even the advantages of notification. They object to have their infectious diseases brought under the focus of the State lamp.

The objection hardly requires serious answer. No one has a right to spread infectious disease through the State, however free and enlightened the community may be. A man is master of his own actions so long as those actions do not jeopardise the safety of his fellows; and, as I have shown, no system can be effective without being complete, and none complete without State compulsion.

2. Next comes the important phase of the question, How is the system of notification of infectious disease best carried out? Herein lies the *crux* of the whole question. There can be little doubt of the utility of the system. There is a good deal of doubt as to where responsibility shall lie. The voluntary system has been considered and condemned. The compulsory system remains. Is it to be compulsory on the householder, the medical attendant, or on both? If the responsibility devolves on the householder alone, complete registration can hardly be looked for; want of opportunity, ignorance, and poverty will now and again almost compel omission or at least tardy notice. A disinclination on the part of the relatives of the sick to have a public medical officer thrust in on the scene, or of having the patient sent off to some hospital, with perhaps destruction or damage to some of the surroundings of the patient, or the risk of themselves being isolated in quarantine, or of injury to business, would assuredly prevent complete returns. Still, the householder must not be exempted, as from the fear of such consequences as the above he may be loth to send for a medical man at all when there is a suspicion of anything infectious. The Act of 1879 is very explicit as to the householder or person who is responsible (section 55).

On the other hand, some contend that it is the medical attendant who should be compelled to notify. Then there are the two phases of the dual method—(*a*) that the local authority should be informed by both the householder and the medical attendant; and (*b*) that it should be compulsory on the medical man to inform the head of the household in writing as to the infectious character of the disease, which information the householder should be bound under a penalty to transmit to the local authority. The question is a nice one; there is no doubt that the medical man is the best qualified to give the information from his knowledge of the case and of the surroundings, but the householder must not be exempted, for the reasons already stated. In most cases where the dual system obtains the local authorities, recognising the additional responsibility thrown on the medical man, give a small bonus for each case notified: at one time 5s. in Birmingham, 2s. 6d. in Edinburgh and other places; now 2s. 6d. and 1s. for cases reported from hospitals. There is also a penalty of 40s. in case of neglect. This helps to make the registration more complete, and is therefore desirable. At a meeting of the Society of Medical Officers of Health, held in December, 1875, it was unanimously resolved that—

1. Infectious disease ought to be reported by the housholder to the sanitary authority without delay.
2. Every medical man attending a case of infectious disease should give immediate information respecting its nature to the occupier or other person responsible for reporting to the sanitary authority.

Since that date it has been found in practice that the notice must come from the medical man. In one town only has notification by the householder been tried—viz., Greenock; and, as might be expected, the results are very unsatisfactory, as only something over 50 per cent. of the cases came to the knowledge of the sanitary authorities; but even under these circumstances the death-rate of the town diminished progressively and considerably. It is therefore clear that with a more complete system a proportionately greater advantage would be gained. Dr. Wallace, Medical Officer of Health for Greenock, concludes a valuable and interesting report by expressing a fear that "no further material improvement will take place from notification by the householder."

Notification by the medical attendant has been opposed by some on the ground that it is a betrayal of that confidence which is necessary between doctor and patient. Such might be the case if there were no compulsory law requiring it; if the object were to injure instead of benefit the patient and the community, and if all medical men were not placed under the same obligation to notify. When, further, it is the rule of the householder as well as the doctor to notify, the former can have no possible ground of complaint in that direction. *Salus populi suprema lex.*

Up to 1886 thirty-eight of the largest towns in Great Britain adopted compulsory notification, and of these thirty-four had adopted direct notification by the medical man, while thirty of these required notification also from the occupier; in three of them only did it rest with the medical man to notify indirectly or to the occupier, so that the dual system was by far the most in favour. It is the one recommended by the Local Government Board in 1878, and by the Select

Committee of the House of Commons in 1882; it is theoretically the only efficient one, and in practice it has been proved to act satisfactorily. At the seventh International Congress of Hygiene and Demography held in London, August, 1891, Martin, of Paris, proposed that compulsory notification of infectious diseases was desirable, and that it was best effected by the dual system; the proposition was carried by overwhelming majorities. The discussion shows that the system is in vogue in Germany, the United States, and Canada, in none of which places is there any fee payable for notification. The reasons why the medical man should notify are so plain: He alone is qualified to diagnose the disease; he alone, bearing in mind the ignorance, poverty, and other disqualifications of large numbers of persons, is qualified by his education, his appreciation of the necessity of the case, his freedom from interest, prejudice, alarm, or confusion, to notify it, and he would by his direct action save much unnecessary delay. The Infectious Disease (Notification) Act requires both householder and medical man to notify.

A moment's reflection will show how far-reaching the benefits of compulsory notification are. Chiefly, the discovery of these first cases, which may swell into an epidemic, their isolation and removal, and the consequent prevention of dissemination by public vehicles, laundries, shops, dairies, lodgings, schools, &c., &c.

It acts hand and glove with the sanitary inspector's work. Typhoid is notified and is traced to a dairy, and the sanitary authority steps in; visitors go to a lodging-house at, say, a watering-place, and contract scarlet fever or typhoid; the disease is traced back to there, and the place disinfected or the drains attended to. Respectable hotel and lodging-house keepers would rather welcome the inquisitorial inspection of a sanitary officer, as they could then say they could show an official "clean bill of health." In case of an epidemic it would force the hand of the local authorities to provide hospital accommodation. I am certain that if the system of notification had been in existence in Brisbane during the last scarlet fever epidemic, from the beginning of that epidemic, hospital accommodation would have been provided months before, and many lives might have been saved.

Moreover, it is now agreed that different epidemics of the same disease vary much in malignity, and it is only from notification returns, not from mortality returns, that the prevalence and cause of mortality can be determined.

Results.—Speaking generally, notification has succeeded in largely reducing the spread of infectious disease and in decreasing the mortality, though to what exact extent remains to be seen, as sufficient time has not yet elapsed to give accurate estimations. Instances such as this may be multiplied:—Portsmouth Medical Officer's Report for 1893 gives in ten years preceding compulsory notification the average on male death-rate of notifiable diseases as 1·54 per 1,000. In the subsequent ten years with compulsory notification the rate fell to ·71, a decline of 54 per cent., while the diminution in non-notifiable disease was only 3 per cent. (B.M.J., 16th June, 1894.)

The B.M.J. for 16-12-93 contains a special report to the Parliamentary Bills Committee of the B.M.A. on compulsory notification in England and Wales in 1892.

On 31st March, 1892, the Infectious Disease (Notification) Act of 1889 had been adopted in 1,051 sanitary districts, of which 622 were urban. 408 rural, and 21 port districts, with an aggregate population of 15,902,343 persons. The Act is in force in London with a population of 4,211,743, and fifty towns have a system of notification under local Acts, affecting 3,878,625 persons, the aggregate population thus placed under compulsory notification being 23,992,711 out of a total population in England and Wales of 29,002,525 persons—*i.e.*, 83 per cent.

If we except London, we find on the date in question 19,780,968 persons out of 24,790,782, or 80 per cent., were under a system of compulsory notification voluntarily adopted. Moreover, nine towns had substituted the provisions of the General Act for those contained in their local Acts.

In 1892, in England and Wales, we find altogether 181,461 cases notified, including smallpox, cholera, diphtheria, membranous croup, erysipelas, scarlet fever, typhoid, typhus, relapsing and continued fevers, puerperal fever, with a general mortality of 8·4 per cent., at a total cost of £21,000. You will observe that measles is omitted, both on account of the enormous expense (£61,250) which its notification would entail and on account of the impossibility of restraining the spread of that epidemic to any great extent, the infective character of the disease being pronounced at so early a stage, and the insuperable apathy of parents to the real danger of so common a disease.

Returns such as the above should be made compulsory annually, and in ten years' time would furnish an invaluable aid to the correct understanding not only of the rates of attack in each part of the community from each of the several diseases, but also of the equally important and little understood point of rates of mortality; and I venture to predict that the expense incurred by any community would be shown to bear a very infinitesimal ratio to the number of valuable lives thus saved.

In Queensland, leprosy, smallpox, and cholera are permanently provided for by Acts enforcing notification and isolation; and measles and scarlet fever have been from time to time placed under compulsory notification provisions, but the Central Board of Health have drawn up regulations within the last few months which have for their aim the compulsory notification of diphtheria, membranous croup, typhoid, measles, and scarlet fever, in addition to the three diseases mentioned above; and it is hoped that before long we shall have a compulsory notification Act on the lines of the English Act. The primary necessity of appointing medical officers of health for the due carrying out of these regulations is now occupying the attention of the board. We shall be glad to hear from some of our southern visitors what has been done towards compulsory notification of infectious disease in their several colonies.

To summarise in conclusion, I am distinctly of opinion that a *compulsory* notification Act which would ensure early and complete intimation of the existence of infectious disease would save to the community a large number of valuable lives, would greatly reduce the expense which inevitably accrues when an epidemic obtains a footing in a community, and would in due time do away with the expensive and harassing system of quarantine which now obtains.

8.—FEDERAL QUARANTINE.

By Dr. K. I. O'DOHERTY, F.R.C.S.

I propose to bring under the notice of this learned Conference probably the most interesting sanitary question of the day, involving as it does the problem whether we in Australia shall follow the example set us by our Imperial sanitary authorities in abolishing our quarantine establishments—our old and time-honoured instruments of protection from infectious and contagious disease--consigning them to the "Limbo of exploded superstitions," to use the language of our Imperial cousins, or shall we, guided by the almost unanimous advice of our Australian sanitary authorities, still stand by our citadels, simply modifying them with a view to rendering them more effective at least cost and trouble.

I confess to being one of those who are prepared to stand by quarantine for Australia, modified according to the views first promulgated by Dr. McKellar, of Sydney, eleven years since, and one year later unanimously agreed to by the important conference of the leading men of Australia in sanitary science, who not only adopted Dr. McKellar's idea as their platform, but after prolonged discussion formulated a plan of federal quarantine even to its minutest detail, a copy of which was forwarded to the Government of each of the Australian provinces, recommending its adoption.

Dr. McKellar's proposal, thus fortified by the unanimous approval of the sanitary authorities of Australia, was made not alone with a view to greater efficiency but also in the interests of economy. He proposed that in addition to the quarantine station, which necessarily should protect each of our great maritime cities, there should be established at the north-east of the continent at Thursday Island, or thereabouts, and also at the south-west—say, at Port Albany—two first-class quarantine stations fully equipped, and at all times to be ready to cope with any plague-ship that would seek to pass either barrier. He proposed that these establishments should be erected and maintained at the cost of all the colonies, the cost to each being estimated according to its size and population.

Dr. McKellar argued—and in this argument the conference agreed —that the different Australian provinces contained within the continent proper and Tasmania had nothing to fear from infectious or contagious disease except from the north; and all vessels coming from the north must touch the continent first at these two ports east or west; and he justly argued that his two federal stations would serve the purpose of two impregnable fortresses that no dangerous, contagious, or infectious disease could pass if organised on an efficient basis and supported by all the colonies.

Ten years have elapsed since those proceedings of the conference took place, and as yet no response has been made by any of the Governments applied to. The Hon. the Colonial Secretary of this colony recently informed me that the question would probably be brought up at the coming meeting of the Federal Council, but such is the apparent diffidence of our Governments to touch on federal matters that I for one have not much confidence in anything being done unless further pressure can be brought to bear upon them.

When Dr. McKellar first brought this question before us, and proposed it as a modification of our present arrangements, calculated to give the colonies much better protection at less cost and trouble, he justified himself by the following remarks, which appear to me to be full of wisdom and timely warning. The quotation is taken from the address given by him before the Royal Society of New South Wales in the year 1883:—

"Hitherto we in the Australian colonies have enjoyed a remarkable immunity from epidemic sickness, owing, no doubt, chiefly to our geographical position. Situated as we are at a great distance from those countries with which we have had any considerable trade, diseases have had time to develop and die out during the necessarily tedious voyage of vessels carrying passengers to our shores; but now, when in a few weeks rapid mail steamers bridge over the distance which at one time took as many months to traverse, we can hardly hope to obtain protection in this way. And, moreover, our trade with India, China, and the islands of the Eastern Archipelago—countries distant but a couple of weeks' sail—is rapidly developing; and I am afraid that it is from this source that we may one day receive a blow, in the shape of some terrible epidemic, which half a century's prosperity will hardly suffice to repair."

Since the utterance of these words we in Queensland have had more than one object lesson calculated to emphasise the doctor's prophecy. During the months of last May, June, and July, as you all are no doubt aware, an outbreak of the terrible bubonic plague or black death occurred at Hongkong, and carried off during that period no less than 150,000 of the inhabitants of that city, besides many thousands more at Canton and in other towns in the vicinity. A steamer called the "Chingtu," regularly trading between that city and Sydney, brought with it, it was supposed, a case of this terrible disease. I say "supposed" because I believe there was some doubt in the matter. However, on touching at Thursday Island, the quarantine officer reported the case to the Government, who were not prepared for so terrible a visitant, and instructed the authorities at Thursday Island to have every precaution taken to prevent the extension of any disease on board the steamer, whilst she was directed to proceed in quarantine to the port of destination at Sydney, not touching at any other port. As far as I have been able to learn, the patient died on the way down, and no other case appeared, and thus happily this colony was possibly saved from the catastrophe suggested by Dr. McKellar.

Nor was this the only escape we in Queensland have had of a like kind since the doctor's warning. But a few years since the plague of Asiatic cholera was brought to our shores by the steamship "Dorunda," recently wrecked on the coast of Portugal.

She was one of the passenger steamers belonging to the British India Company trading regularly to this colony. On her voyage from Europe she always touched at Batavia, where on one such voyage she picked up this pestilence and brought it to Queensland. No symptom appeared on board until she had reached our northern coast, where the disease broke out in its usual malignant form.

Having emigrants on board, who should have been scattered through the towns along the coast, the Government had to step in and save the colony by ordering her to steam rapidly to the head quarantine station in Moreton Bay, not touching at any port on the way. Every effort was made to stay the progress of the disease on board, but notwithstanding all that could be done seventeen lives were lost before the disease was starved out at the quarantine station. We had, however, the satisfaction of not allowing the dread malady to find a landing-place on our continent.

Whilst we are quite prepared to concede that in the case of the British Isles and the thickly inhabited continent of Europe, with a population of hundreds of thousands for our units, rigid quarantine is no longer possible, nor indeed called for, for the simple reason that the plagues of the northern hemisphere have become as it were acclimatized there, cholera, smallpox, typhus and yellow fever, &c., having become endemic throughout, it has become no longer possible for quarantine to shut them out or control them, besides which the disturbance to the vast trade and commerce carried on throughout the continent, necessarily caused by the quarantine law, has become so intolerable as to threaten the existence of healthy commercial life, if rigidly enforced.

We therefore do not wonder that the sanitarians have determined, as was clearly shown at the late important conference at Dresden, to adopt as far as possible the principle of *examination* and *purification* in lieu of *detention* and *isolation* in their future dealings with infectious and contagious disease. This policy is all the more rational and easily understood when we take into account the vast strides which have been made in recent years in the sanitary organization and control of the cities and towns throughout the continent of Europe.

Whilst we in Australia are quite prepared to concede all this to our Imperial sanitarians, we nevertheless claim for Australia that no such time has arrived for us. With our scattered population, our, as yet, insanitary towns and cities, we are in no such position as our European brethren to meet this hydra-headed monster face to face, nor can we expect to be for a long time to come; and our only hope, therefore, rests upon our ability to continue effectively our present policy of keeping our doors shut to prevent the enemy entering.

Such, if I mistake not, was the unanimous decision of the conference that assembled at Sydney ten years ago, and such, again, was the practical response recently given to the suggestion of the Imperial authorities asking the colonies to join in the Dresden convention. In the position I had the honour to hold at the time this proposal was made—that of Secretary of the Central Board of Health of the colony—it was my duty respectfully to advise our Government to decline on behalf of Queensland to be bound by the terms of that convention, and I believe the decision of the Queensland Central Board echoed the general sanitary opinion of Australia; and I am persuaded that in now urging upon our provincial Australian Governments to lose no further time in sanctioning the proposal of the conference held in Sydney in 1884, I shall voice the opinion of the great majority of Australian sanitarians.

One suggestion I would venture to make, arising out of the changed aspect of the colonies during the ten years which have elapsed since the Sydney conference formulated its demand for federal quarantine—that a third federal quarantine station has become a necessity somewhere in the neighbourhood of Port Darwin, which has become a sort of highway for our Chinese brethren to push their way into Australia.

I would further express the opinion that whilst we have good reason to complain of our respective Governments being too dilatory in responding to the request of the Sydney conference of 1884, it is certain, notwithstanding, that the principle underlying Dr. McKellar's proposal for federal quarantine has already taken root, and is now being acted upon in, of course, an imperfect manner. Although no federal quarantine station exists either at Thursday Island or Port Albany, there is evidently a close watch kept at both places by the quarantine officers located there to prevent any contagious or infectious disease being permitted to pass without due notice being given to their respective Governments, and thereby to all Australia, enabling immediate defensive measures to be taken wherever they may be required.

The somewhat imperfect pictures I have ventured to lay before you of federal quarantine, as proposed by the Sydney conference of 1884, has such obvious advantages over our present quarantine arrangements as to be self-evident. That it would result in a considerable saving of time, trouble, and expense to all the colonies no one can doubt, as well as that it would give much greater confidence and security against the admission of most of the dangerous, contagious, and infectious diseases always to be apprehended from the thickly-inhabited and insanitary countries to the north of us, with whom we are becoming day by day more intimately connected commercially.

I do not consider, however, that I should be doing full justice to my subject were I to omit the warning that, however we may praise federal quarantine as a secure barrier against the admission of these formidable diseases, it is after all but a barrier which, in the ordinary course of events, is certain to fail once and again in preventing the enemy passing through and finding a resting-place in our midst.

It therefore appears evident to me that any future proposal to adopt it in lieu of our present system should be accompanied with some such code, if not the identical one, of internal sanitary arrangement as has been adopted in Europe, throughout which continent it is now actively enforced, under the terms of the Dresden convention.

Although I for one am in entire accord with the Central Board of Health of this colony in declining to advise our Government to join in carrying out the full terms of the Dresden convention in these colonies, simply because, owing to the scattered nature of our populations and the insanitary condition of all but our capital cities, it would be impossible to do so, I am nevertheless strongly of opinion that all the colonies included within the Australian continent, and Tasmania as well, could with great advantage copy our European brethren in devising a code of sanitary regulations applicable to the whole continent which would not alone guard us against the progressive ravages of so terrible a visitant as the cholera, the special enemy against whom our Dresden friends directed their efforts, but would serve us as effectively against the smallpox, the typhus and yellow fevers, or any other of the formidable Indian or Asiatic plagues which have not yet found a footing in our continent.

In this connection it would be desirable to bear in mind, in drawing up such a code, that whilst the Dresden conference considered five days as the incubating period of cholera, and decreed that passengers travelling by sea or land, either by ship or train, who had not exhibited for that period any symptoms of cholera, might be safely allowed to land—it mattered not if they came direct from an infected port, or if they carried the disease with them for a time, if within six days before arriving no symptom of the disease appeared the passengers are allowed to land and any goods to be sent on shore—it is added, however, "*if the proper disinfection has been carried out.*" This latter proviso may make a difference, but certain it is that we in Queensland had an experience in the case of the s.s. "Dorunda," to which I have already referred, that so short a period as five days would not be sufficient protection, inasmuch as the evidence was conclusive at the inquiry held on that occasion that no trace of the disease appeared until the period of twelve days had elapsed after she had left the infected port. I may add that in one of the last kindly discussions I had with our late respected medical brother, Dr. Joseph Bancroft, he expressed himself very strongly against limiting the incubating period of cholera in Australia to five days.

In conclusion, I trust I may, without presumption, venture to suggest to the Conference, in consideration of the extreme importance of the subject, that the opportunity afforded by this meeting should not be allowed to pass away without some action being taken. It should be borne in mind that, as far at least as I am aware, no combined answer has been given to the question put some months since to the colonies by the Imperial Government, "Whether they would join in the Dresden convention, and if not why not?"

I respectfully submit this would be a favourable time, and this Conference would be an appropriate body to perform such a duty. On the one hand to satisfy the Imperial authorities that the colonies are not as yet in a position to justify their joining the convention, whilst on the other hand they are anxious and willing to follow their European brethren as far as they can in the march of sanitary progress.

In my humble opinion there ought to be little difficulty in a committee of this Conference taking the annexures of the Dresden conference, especially Annexure I., as the framework of a similar code of sanitary regulations for Australia, which, if worked in conjunction with federal quarantine, would give the colonies the best chance of still retaining the proud title of the virgin continent.

9.—THE SANITATION OF COUNTRY TOWNS.

By ÆNEAS JOHN McDONNELL, M.B., &c., Ch.M., &c.

10.—THE HYGIENE OF DRESS, WITH SPECIAL REFERENCE TO QUEENSLAND.

By LILIAN COOPER, L.R.C.P. and S., &c.

11.—THE DISTRIBUTED CENTRE SYSTEM OF MECHANICAL SEWAGE TRANSMISSION.

By ROBERT WILSON, M.Q. Inst. Mech. Engineers.

12.—NOTES ON PHTHISIS.

By GEORGE LANE MULLINS, M.D.

13.—SEGREGATION OF LEPERS IN AUSTRALIA.

By A. E. SALTER, M.B.

Section J.

MENTAL SCIENCE AND EDUCATION.

1.—REPORT OF COMMITTEE ON THE BEST MEANS OF ENCOURAGING PSYCHOPHYSICAL AND PSYCHOMETRICAL INVESTIGATION IN AUSTRALASIA.

Members of Committee:

Professor H. Laurie	Mr. J. T. Collins
Mr. J. A. Hartley	Mr. T. Brodribb
Mr. H. P. Gill	Mr. E. F. J. Love (Secretary).

The committee has been engaged in obtaining from England and America information which may be of service as leading to definite recommendations. The information received is not so complete as might be desired; and, as the secretary is now visiting Europe, and has kindly undertaken to make further inquiries, the committee asks that it be reappointed, with power to add to its number.

Meantime it reports as follows:—

Psychophysics.—The most valuable information on this subject has been received from Professor Titchener, of the Cornell University, New York. After enumerating the various subjects which may be included in experimental psychology, Professor Titchener mentions the following requisites:—(1) An endowed chair, to be held by a professor who has had special training in experimental psychology; (2) a library; (3) an endowed laboratory, having a minimum of six rooms, and with an assistant or assistants. Professor Titchener, whose letter is submitted with this report, generously offers all the assistance in his power. The committee thinks it important that the character of the work now being done in America in experimental psychology should be widely known; but, while arrangements such as those described are worthy of the Cornell University, where in the school of philosophy alone there are eight professors and lecturers, the committee feels that it would be useless to propose so great an extension in the present financial position of the Australasian universities. For the present the committee recommends that the professors of mental science in our universities be asked to place themselves in communication with the professors of physics and of physiology, and to report what initial steps in experimental psychology are in their opinion possible. A beginning may be made by interesting students in the more elementary work.

Psychometry.—Owing to the debased meaning which has been attached to this word by some writers, it may be worth while to mention that it is here used in the legitimate sense of the measurement of mental powers and capacities. It has been the special aim of the committee to devise a scheme of statistical inquiries, of theoretical and practical value, in connection with the State school systems of the

Australasian colonies. Such a scheme should be at once simple and precise in order to secure accurate returns, and should also fall into line with similar investigations which are being prosecuted elsewhere. Mr. Francis Gatton, whose psychometric experiments render him a leading authority on this subject, has favoured the committee with several suggestions. At the same time, he urges the need of careful deliberation, and of an adequate knowledge of the programmes which have been carried into effect in the United States. "All this," he remarks, "will require a full year; but anything is better than the waste of money and the damping of enthusiasm due to an ill-considered start." In accordance with this advice, the committee has sought for fuller information as to what is being done in the States, and also in the Board Schools of London, and defers any recommendation till this has been received and considered. Mr. Gatton's valuable letter is submitted for perusal with this report.

HENRY LAURIE,
Chairman of Committee.

31st December, 1894.

2.—USE AND ABUSE OF EXAMINATIONS.

By HENRY BELCHER, M.A., LL.D., Fellow of King's College, London, and Rector of the Boys' High School, Dunedin.

Bentley,* in establishing examinations for the juster award of the Fellowships of Trinity College, Cambridge, would seem to be the father of the present system under which every man is athirst to examine his neighbour. The second impulse is due to Brougham.† Then let us reckon Macaulay,‡ who vigorously pushed the cause of education mainly because education should be the cheapest defence of the rights of property. In support of his contention he cites the brutal ignorance of the mob in the Gordon Riots of 1780. According to this view the Chicago Riots of 1894 should have been impossible. Then comes Lord Sherbrooke, a man of Australian experience, better known as Mr. Lowe. Mr. Lowe is one of the extraordinary Englishmen of our century. He had no belief in education. He never would allow that education contributed to his own remarkable influence and success. He did not admit the existence of any science of education. He scouted the notion that to the working classes education can be of any profit. These views are expressed in a memorable address to the Philosophical Institution of Edinburgh§. Such was the attitude towards education of the author of the Revised Code. This is now admitted to have been the worst instrument of its kind yet devised by the wit of man. It has been condemned by every educationist of rank not in Government employ, and by the majority of those who are in Government employ. To him we owe the conception that there are

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* Cambridge is the source of the modern examination system. Latham: Action of Examinations, p. 151. First Tripos List in 1748: id. p. 133. Sir Geo. Young: International Educational Conference, iii., p. 249.

† Schmidt, quoted by Donaldson: Hist. of Education, p. 66.

‡ Macaulay: Speech on Education, 1847. Macaulay, when Secretary of War, established girls' schools in connection with every army corps.

§ Donaldson, *ibid.*, p. 83; and Sir James K. Shuttleworth on the Revised Code, *ibid.*, p. 85.

six grades of knowledge which between the ages of seven and thirteen every child should attain. He invented the Sixth Standard. He was for many years member for the University of London, which is perhaps the fullest product of the examination system Mr. Lowe did so much to foster. The work of this University is summed up in a report presented to its Convocation seventeen years ago*:—"The beneficial influence of the broad and searching system of examinations which has gradually been elaborated during the last forty years by the Senate is one of the best titles of the University to respect. This influence has been exerted upon all the higher education of the country, directly upon the schools which send up candidates for matriculation and the colleges and medical schools, and less directly upon professional and scientific training generally, as well as upon the examining systems of the older universities."

Since the date of that report much has occurred in the way of extension of examination, to which the latest proposed addition comes as a suggestion from Mr. Walter Besant, that journalists should submit to a system of examination.

After sixty years of steady expansion the examination system shows little evidence of weakening.† The principle involved is quite inseparable from the processes of education. What the teacher catechises in, he should at the proper time catechise out. In this way he stimulates the intelligence and tests the progress of his pupils. He can have no evidence of the value of his work except by a series of challenges skilfully adapted to the comprehension of the learner. No one can be said to know a fragment of his subject unless able to produce in his own words a substantial amount of what he thinks he knows. Under the catechetical test all flaws and gaps due to imperfect apprehension, to carelessness, to defective memory are rapidly and clearly revealed. In the hands of a skilful teacher a learner is turned inside out as neatly as Lucian makes his puppets do for each other in the "Dialogues of the Dead."

Examinations of this kind as between a man and his class lie altogether under his own control. He knows what to expect, what he may fairly exact, and how to render his process suitable to the person and to the subject in hand. He is arbiter of the manner, the matter, and the result. Much first-class work of this sort is daily and hourly done in every reputable place of education throughout the world, while from the nature of the case the mass of examination work is effected in class-rooms between teacher and pupil.

It is held by many men of high repute that in the extension of examinations to wider and more responsible spheres this is the best principle to apply. In academical work of university rank, it is frequently contended that professors are best fitted to conduct the examinations of their own students.

This claim was advanced in 1884 during the agitation for the establishment of a teaching university for London.

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* Convocation Reports: 1877-1878, p. 50.

† During the last ten years in Great Britain correspondence has replaced other means of coaching for examinations. This way of question and answer is used in preparation for examinations of all kinds. The educational journals witness to the thriving nature of this enterprise. "Successes" form the chief detail of the advertisements.

It was felt that familiarity with the course of methods of study is as beneficial for the end in view as the independence and stimulating innovation likely to ensue from the introduction of an outsider.*

Examiners connected with an institution are more likely to find means of urging on the examinee to put forward what he should know, while men from outside are likely to stumble on matters the examinee does not know or should not be expected to know.

On this point Mr. Lowe's opinion was that teachers should not be left "to brand their own herrings."

Doubtless this view of the dual control of the teacher is open to much consideration and argument; but in Germany the view is not only favourably entertained, but the practice is followed.

In the German high schools certificates are awarded by the rectors, after examinations conducted in the presence of a Government official by the rectors and their assistants.†

This leaving certificate is the matriculation certificate which a pupil may present at the doors of any university within the German Empire and be admitted. There is, as a matter of fact, within the German Empire no matriculation examination as understood in these colonies and by many universities in Great Britain. It has not been hitherto contended that Germany is behind other countries as to higher education, or that this larger freedom accorded to German teachers has been abused.

This application of a fundamental process of education to more advanced purposes brings examinations directly under public notice. Public examination has become a power behind the teacher almost indispensable to his efficiency, and thus is a potent factor in general education. It provides that element of drill, of trial, and of shock, such as in the general order of life is found at some stage in every department of practical affairs. This seems to me the most solid benefit ensuing from public examinations. The main drawback, however, is that the best part of a teacher's work escapes analysis; the methods of higher teaching rise in quality and character, while the methods of examinations lag behind.

During the brief previous review, examinations have been regarded as subsidiary to the purposes of education; but soon after the extension of the examination system with which we are all so familiar it soon became manifest that examination aimed at becoming the controller and mistress of education.‡ And such is actually the position of things to-day. During the last sixty years a complete revolution has overtaken the conditions of education. To pass examinations has become almost a profession.§ There are many young people who, by passing examinations, begin to earn a partial

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* University of London Convocation Reports: 1877-1878, p. 47.

† Latham, p. 64: "It is one of the drawbacks to the use of examinations in general that they tend to crush spontaneity both in teacher and pupil, and this tendency is far greater when the examination is supreme and external to the teachings than when the teaching and examining bodies are one, or when in some way each can influence the other."

‡ This was felt nearly twenty years ago. Serious doubts were expressed in 1876 as to the superlative value of even the best examinations. It had been said in 1873 that competitive examinations are destructive of all learning; a charge repeated by Sir Geo. Young in 1884, and by Prof. Freeman in 1888. *See Nineteenth Century*, November, 1888, p. 619: "A Protest."

§ Latham, p. 1.

livelihood at thirteen years of age. For the next ten years they may win by prizes in money as much income as the pay of a subaltern in the British army.* Their whole subsequent career is determined by early successes. This is a fact in the consideration of the subject to inspire grave reflections, for it is really the key of the whole situation. Hence a brief review of the rapid rise of the examination system is at this stage necessary.

On the introduction of public examinations their influence on school education was at once alterative and prophylactic. It had for many years been the custom that anywhere within the British Empire a school might be set going by any man, whatever his qualifications. Private-adventure schools have been conducted in Great Britain in a way that leave an indelible impression upon our literature. According to Macaulay, in his day the owners and masters of these schools were frequently old soldiers,† footmen, broken-down publicans, and prize-fighters. They owed no duty to any council or governing body, but only to parents, of whom many would interest themselves in education only to obstruct it by mischievous interference or foolish indulgence. The better class of private schoolmasters used to issue reports which fell into hands either incapable of verifying them or not unwilling to be misled. Such schools were nothing better than cheap lodging-houses for children, and not unseldom mere baby farms.‡ On this class of school the public examinations introduced by the College of Preceptors, and subsequently by Oxford and Cambridge, acted with remarkable results.

"For when one school in a neighbourhood began to send in its boys for these examinations it was not unnatural that the parents of pupils at other schools of like character should inquire why their children were not prepared for a similar test, and if the same state of things continued, or if excuses were made, the parents began to think there was something rotten in the state of a school which could not do what its neighbours did. Then, if, under pressure, boys were sent in it became most desirable, from the schoolmaster's point of view, his boys should pass; if they did not, or if another establishment in the neighbourhood was more successful, his school would be sure to suffer, hence the general improvement in work in many places was the result, and these examinations afforded something like a general test for schools of a certain class throughout the country, for which every school with any pretentions to efficiency had to enter. Thus the establishment of these examinations has been improving to such schools, and has stimulated the education given in them."§

This initiative attracted the attention of Parliament, which passed an Endowed Schools Act for the improved control of endowed schools. In all schemes under this Act occurs a clause directing the examination

* See *Ch. Times*, 14th September, 1894. A school advertises as having gained £4,725 in scholarships alone; another mentions that it has £700 to give away.

† Inquiry into the state of education in Monmouthshire, 1839. Perhaps there is no literature in which schools play such a prominent part as in our own. See "David Copperfield," "Great Expectations," "Our Mutual Friend," "Nicholas Nickleby," "Edwin Drood," "The Old Curiosity Shop," "Jane Eyre," "Adam Bede," "Eugene Aram," "Vanity Fair," "Pendennis," with many others. Blackmore's latest novel adds "Sergeant Jakes" to the long list.

‡ Recent inquiries at Hackney show that even now Government institutions may be a only little better.

§ R. B. Poole, D.D., I.C.E., 1884, vol. iv., p. 205.

or inspection of such school every year.* The Act is now very generally enforced. The legal requirement specifies an alternative between examination and inspection, leaving it to the school authorities which course to pursue. It is unusual to publish the ensuing report except as a mere advertisement. The common sense of boards, aided possibly by the reluctance of newspaper managers to burden newspaper columns with matter of such purely local interest, checks the publications of these reports, which, in the case of a school as a going concern in a normal condition, is a dangerous and possibly a mischievous step. The public is, on the whole, somewhat sceptical, where it is not censorious. It discounts approbation and exaggerates the effects of adverse criticism. Under these well understood conditions, examiners and inspectors shrink from opening their minds if the ultimate destination of their remarks is the columns of a newspaper. Reports to be minutely diagnostic should be relatively confidential; consequently, if the practice of publication prevails, boards do not get what they should get. I have known a man of high position submit two reports—one for publication and one for private and confidential consideration. I have known another refrain from mentioning serious defects as well as admitted excellencies, thinking it the best policy to be quite colourless. These evasions rise out of the habit boards frequently contract of standing by systems rather than by men. The framers of the regulations under the Act quoted above placed for the object in view inspection abreast of examination. Inspection is an invaluable process; it reviews the health and strength of the living school. A good inspector should have a quick mind, an experienced and chastened judgment, an observant eye. With these facilities and acquirements he comprehends almost at a glance the condition of a school. He is like a good doctor to whom is submitted the passing for public service of a strong, sound man. Such a doctor by a rapid estimate of his immediate observation grasps at once the corporal condition of his subject. Similarly a good inspector entering a school notes the order and the discipline, the relations maintained between teachers and taught, the efficiency of the staff, their capacity, and their knowledge. It is not requisite for him to be the master of the subjects handled by the boys; it will suffice that he know one or two subjects very well, and be tolerably conversant with the elements of the remainder. He may not, for instance, be proficient in French, but he may judge whether a teacher is fairly proficient by observing the class under instruction. To convert the famous opinion of Aristotle† to the service of the present remarks, in teaching a class a man may be able

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* "There shall be once in each year an inspection or examination of the scholars by an examiner or examiners appointed by the governors and paid by them, but otherwise unconnected with the school. Examiners shall make a report in writing to the governors on the proficiency of the scholars, and on the position of the school as regards instruction and discipline, as shown by the results of examination. The governors shall communicate to the head master or mistress the report relating to the school." There is no provision in the Act for the publication of the report.

† Arist. Rhet. 1, 1, 11: "Mankind has naturally a tolerable tendency to what is true, and generally likes the truth."—*Ibid.* 1, vii., 28. "What everyone chooses is better than what some do not, while the deliberate choice of a majority is better than that of a minority."

Id. Politics 1, 11, 11: "The people are the best judges of the details of music, and the works of poets. For one man knows one little matter thoroughly, and another, another—and so all collectively the whole."

to conceal from an individual here and there his defective knowledge, but he cannot conceal it from all. The boys may be slow in finding a man out, but it is certain they will ultimately find him out, and in such a case boys are merciless. An inspector has then an almost infallible test under his immediate notice. Again, he observes the order and discipline of a school. These matters constitute the thrift of the institution; wasted time, wasted work, are the costly price of laxity, behind which mischief certainly comes a fall in the standard of efficiency and of results. It is well known that the ripest and most profound scholars and thinkers occasionally fail in the power of discipline. The very eminent Frederick Denison Maurice lectured amidst continuous uproar. That famous electrician James Clark Maxwell's class-room was usually a bear-garden. Blackie, of Edinburgh, and Bentley, of King's College, London, are similar instances of this deficiency of control. The noise and confusion of some school-rooms have been such that, in his young experiences at Marlborough, Farrar said a teacher required the voice of a Stentor, the hands of a Briareus, and the eyes of an Argus. Nothing in its own way is so pitiable as the spectacle of a man who can teach, but is unfit for rule. An inspector thus requires no great insight to perceive where discipline reigns or where it fails. But to find the complete inspector is admittedly a difficult question. For, as Dr. Fitch remarks: "Anyone with a full knowledge of the subject taught, and a little practice in the art of setting questions and in assigning the relative merits of answers, can find out what a class has learned, and can arrange it in order of merit, but to estimate the work of a school as a whole is a much more difficult task. It requires a judicial cast of mind, perfect fairness, and freedom from crotchets, a mind ready to recognise all forms of good work, and a large measure of personal tact, insight, and sympathy."*

Practically the best means of estimating a school as a going concern in the matters of intellectual discipline and moral character is by close inspection.

I am now led to consider the influence of public examination upon school work.

This class of public examination is now very fully in the hands of universities. By way of scholarships, leaving certificates, matriculation examination, and similar devices, universities exert an increasing measure of control over grammar school work. The publishing houses of the Empire offer on this point ample testimony. Every year adds, I believe, to the list of books published for the purposes of certain examinations. Many very adverse criticisms have been offered as to the quality and value of these books, but as they form now an adjunct of the examination system, their influence on education is matter for consideration.

A great many of them have come under my notice, and I may thus venture an opinion that they are at least as good as the better class of the older books displaced. They are at any rate better than Anthon, Ellis, the Delphin additions, with their circumference of crib, and the Irish books. Set books added to the university examinations determine the course of study of hundreds of grammar schools. It

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* J. G. Fitch, in International Conference on Education, I., p. 235. The matter quoted from Farrar above is in a lecture given at Cambridge to the Teachers' Association in 1883, published by Clar. Press.

is to my mind a fairly self-evident proposition that whoever examines controls. What is more notorious, for instance, than that under the influence of the English university locals there are scores of schoolmasters and thousands of boys whose knowledge of Latin literature is confined to certain selected parts of Cæsar and Virgil.* For many years (and it may be still) the College of Surgeons prescribed in Latin for entrance examination one book of Cæsar. A similar body in Ireland pinned its faith and practice in Greek on the "Dialogues of Lucian." This fixed book system as imposed by universities or bodies of university rank is the bane of elementary scholarship, besides being an intolerable yoke and shackle. My experience of New Zealand, with which I am slightly acquainted, leads me to bring forward the subject of Greek as illustrative of the axiom—whoever examines controls. There is in New Zealand an admirable system of leaving scholarships. These are now fifteen in number annually, with considerable money value, and are open without restriction to all-comers. They are controlled as to subjects, tenure, and payments by the University Senate. They are offered at the end of each school year, and naturally attract a great deal of the best school work in all parts of the colony. In this leaving-scholarship competition the university fathers have placed Greek in marking at two-thirds the value of mathematics and Latin, and on a par with English and Elementary Science. To anyone who, as a practical teacher, knows the aggregate amount of work requisite for bringing a pupil to the Greek standard as compared with that needed to bring him up to the Science standard, this estimate seems quite inequitable. What has been the effect? Of the last 100 scholarships awarded under this system, Latin and Mathematics have been taken in every case, Greek in seven.† It is estimated that, setting apart young aspirants to the ministry of Christian bodies, the number of persons studying Greek is so small that the subject has little or no weight in the general apparatus of education. In New Zealand the grammar schools are all endowed—some liberally, others sparingly; hence secondary education stands clear of any disturbing influences. It would seem, therefore, that the decline of Greek in the New Zealand conception of a liberal education is due altogether to the action of the university. There is a curious subsidiary result traceable in what may be called the residuum of local opinion on the matter. To know Greek exposes a man to an estimate of himself that hurts; he is looked upon as one who has wasted serious time—as one who should profess amidst the calls of business to be a doer of catching tricks with oranges or a swallower of knives.

Not to digress further; the main point that whoever examines controls, seems incontestible. For this loss of freedom a teacher should naturally get some *quid pro quo*. There have been, perhaps there still are, certain compensations. In the early epochs of the examination age, many varieties of discipline were called into being at the demand of the schoolmasters. After the methods of Orbilius had gone out of vogue, the methods of those other schoolmasters Horace

* A speaker in 1884, addressing the International Conference on Education, assured his audience that for twenty-five years he had taught nothing in Latin but some Cæsar and a modicum of Virgil. Report iv., p. 215.

† N. Z. Univ. Calendar, 1894-1895, *ad fin.*

mentions in connection with jam-tarts came into the ascendant.* It became the scholastic mode to make things easy and pleasant. Objects were placed before boys to look at; diagrams of the cancerous interior of Napoleon's stomach, skeletons with brass fittings, melodramatic chemical displays in which a bit of lump sugar swelled into a vast cubical mass of solid blacking. With these and similar devices was the pupil amused and instructed. On the top of this amiable method came the principle of moral earnestness and moral suasion.† This was, with a few expounders of educational theories and with some middle-class parents, a highly popular principle. The neophytes of this cult felt somehow that the mantle of Arnold had descended upon their shoulders. But moral suasion was found difficult to work; in fact, it broke down. There should exist somewhere in the background of schools a terror to evildoers, just as in general life behind all marches the policeman. Life is hard everywhere, and when the question is looked into there seems to be no practical reason why boys should pass what is a considerable part of the span of life under a kind of more-favoured nation clause as to their work. Besides, men could not always be on their knees striving for the moral conversion of boys. But the question of punishment being a standing difficulty, and a full reversion to the dominion of the ferule being out of the question, men had to cast about for some new coercive instrument, and discovered examinations to be a first-class substitute for the birch.

In estimating the decline of corporal punishment in the discipline of grammar schools, perhaps adequate allowance has not been made for the expulsive power of this new discipline. As every avenue to life in succession becomes barred by a gate watched by an examiner, so does the mechanical force of the examination mill increase; so also is the schoolmaster supplied with an increasing means of enforcing industry. Intellectual delights belong only to the few; but vanity, ambition, the desire to please, the desire to excel, the desire of independence, these and other motives play their part. The successful examinee enters upon the fruition of all these desires. His name appears in leading newspapers, accompanied in some instances by his biography; his portrait goes the rounds of the British world. In some American States successful boys and girls enjoy the pleasure of seeing themselves pictured in the daily papers. There is a story told of a senior wrangler who declined to appear in a box at a London theatre lest his presence should give rise to popular commotion leading to a suspension of the performance. He thought it prudent to allow the London public time to digest this addition to metropolitan attractions. But they win more substantial benefits than these; they get the pick of prizes, of posts, and rewards.

Examinations thus provide the new model of education. They give the pressure requisite to keep education going. Exertion such as is necessary for elementary acquirement—work at the grammar of

* Hor. Ep. 2, 1-70, and Suetonius de Ill. Gr. 9 quotes Domitius: "*Si quos Orbilius ferula scuticaque cecidit.*" The jam tarts are mentioned, Hor. Sat. 1, 1, 25: *Ut pueris olim dant crustula blandi, Doctores elementa velint ut discere prima.* It appears that in some parts of Brazil cigarettes are served out to children of merit as rewards.

† "No physical force; the moral sense appealed to, the higher qualities educed by kindness, the innate preference of right prompted by self-esteem, the juvenile faculties to be elevated from the moment of earliest development by a perception of their high responsibility." From a circular put out in 1846.

language, at mathematics, at strict science—is drudgery and fag such as the boy's soul abhors. To make the work tolerable at all, it should be in the hands of a man who interests his class not so much in the subject as in himself. A man of this rare but highly desirable kind pulls the work along; but a rigid discipline, a known liability to punishment and loss, do more. They urge a boy to apply himself to what he finds distasteful, and the most valuable of all school learning is to learn to do with cheerfulness what one finds distasteful. Sooner or later, under the spur of necessity, the disagreeable stands in the road. There is much testimony to show that the average man considers the primeval curse on labour to mean specifically that all labour is a curse. Should this be true of the average man, it is likely to be true of the average boy. In this view of the matter the present value of examinations for disciplining purposes is very considerable. What is to be substituted for them is not obvious. In France, where corporal punishment is not allowed, boys are put upon short diet, and interned or gated by way of penalty.* In Germany, unless a boy pass by examination into the highest class but one of the school—unless he continue in that class for one year, conducting himself with diligence and propriety—he is compelled to serve three years in a barracks away from home as a private soldier. On the other hand, should he comply with the conditions, he serves only for one year, and that in the town in which his parents reside. These regulations account for the crowded state of the German gymnasia; yet as soon as this exemption is attained 75 per cent. of the boys quit school.† Neither the French device of the empty stomach nor the German threat of the barrack-yard are likely to be adopted anywhere by the English people. The examination mill is about the most potent machine for enforcing industry that remains to us.

The present influence of examinations owes much to the expulsive force of the system in its early stages. If there were favouritism in the bestowal of lucrative posts, examinations largely discredited favouritism. They did much to extirpate the system of close scholarships. They aided in extinguishing sectarian differences within university walls by bringing into disrepute the notion that the mathematics of a Baptist should be less profitable to him because his view of Christianity is a view that the university should discountenance. Examinations abolished commission by purchase, because as soon as examinations became the test of a minimum of indispensable knowledge and merit it was felt to be monstrous that a meritorious but moneyless young man should be disqualified in favour of a moneyed but possibly unmeritorious young man. And finally, when public opinion began to demand that public patronage in the vast services of the British Empire should be controlled according to some principle, and Lord Macaulay came forward to recommend the principle of competition by examination, the public accepted the suggestion as the only reasonable solution of a very complex problem.

In such matters the public is very hard to move, and equally hard to stop. Having accepted the principle of competition by examination,

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* Latham, p. 61.

† *Id.*, p. 63: In Germany the number of persons attending places of higher education is said to be about 50 per 1,000; in Great Britain, about 15; in New Zealand, about 5. The German 50 are mostly males; the New Zealand 5 are about equally distributed between the two sexes.

the public will, in all probability, push it to extremes* until it becomes intolerable, and provokes the usual storm of reactionary violence. Such a storm brewed, came to a head, and burst in 1888. It was premature, but I think precursive of a more violent outbreak. Does any one recall the title of that vigorous onfall? It was called "The Sacrifice of Education to Examination." All that could be said against the examination system was then conscientiously and vigorously stated. The compilers and framers of the protest insisted that—"At the present time both teacher and pupil are morally depressed and incapacitated by a system that deliberately sets itself to appeal to the lower side of human nature. Again and again brilliant young men, once full of early promise, go down from the universities as the great prize-winners, and do little or nothing in after years. They have lived their mental life before they are five-and-twenty. The victory of life has seemed to them gained, and knowledge exhausted, almost before the threshold of either has been crossed."—*Nineteenth Century*, November, 1888.

I have already laid stress on the fact that examination from being a very useful ally has become the mistress of education. The question then arises—Is examination a beneficent monarch or a despot? Having now said as much in favour of the system as may reasonably be maintained, yet I think, on the whole, the influence of the present vast development of the system is mischievous.

"Its influence," says Sir George Young, "over the highest culture is questionable. The institution at Cambridge of the Mathematical Tripos, it has often been remarked, synchronised with the loss to England of her mathematical pre-eminence. The most valuable advance of England in this century has been in natural science, a region over which until yesterday the examiner held no sway. Classical scholarship has indeed flourished, but classical learning has declined. Literature has owed little to the typical examinee; research still less. The study of law has withered out of our universities, choked by the competition of studies that would pay."†

This is a serious indictment, and it was left unchallenged. The popularity of higher education, if it has not declined, has not increased. Twenty years ago examinations were already under suspicion, but the *Pall Mall Gazette* had not yet hit upon its notorious device of publishing in comparative tables the "successes" of the English schools in order, as it professed, that the British parent might judge where to put his hopeful, with a view to smart payments and quick returns. A few good English schools had the pluck to keep clear of the *Pall Mall* and its wiles, but for two or three years the statistics duly appeared. This proceeding was perhaps the most pointed comment on the ruinous tendency of the examination system. Whatever views a man may entertain of his old school or university,

* It is singular that in Socialist books, or in books purporting to set out the views of Socialists, and in works of fiction wherein the conditions of the future of our race are pictured, severe competitive examinations play their part. I have noticed this frequently, but quote the following:—"Les écoles, et les ateliers sont ouverts, l'enfant choisit librement son métier, que les aptitudes déterminent. Des années déjà se sont écoulées et la sélection s'est faite, grâce à des examens severes. Il ne suffit plus de pouvoir payer l'instruction, il fait en profiter."—*Sigismond*, in "L'Argent" (E. Zola), p. 440.

† Internat. Conference on Education, iii., p. 249.

his memory of examinations should be one of confusion and dismay;* for in these latter days the whole of education is a clatter of examination. Should a boy, as many colonial boys do, proceed through a primary school and a grammar school to a university and his degree, he will in all probability have passed through the mill twelve or fifteen times. In England his case would be worse. There are more scholarships, open competitions, and university boards lying in wait for him in merry England. Hence one is never out of the sound and fury of the machine. What is the result? The speed and fineness of the machine imperceptibly increase. Latham remarked in 1877 that the tendency of all modern examinations is towards augmented abstruseness.† It is a point of honour to invent new questions, because the publication of all previous questions brings them into the common workshop of the crammer. Now, it is the duty of the examiner to outwit the crammer, as it is the task of the crammer to floor the examiner. Consequently, examination papers become more and more a summary of mere side-issues and difficulties connected with the subject of examination. In Latin you get questions on forms of speech that are quite possibly mere blunders on the part of the writers. In arithmetic sums become mere algebra problems in disguise. The French papers are a wrangle with etymologies and points upon which learned Frenchmen themselves have not come to any conclusion. Extend these remarks indefinitely to every point in the circle of knowledge, and one would not be far wide of the mark. Hence the dismay on the face of a middle-aged man—of one whose life has been passed in practical contact with the subjects handled.

Sir Joseph Fayrer‡ challenges his professional brethren, and desires to know whether, should anyone read the papers now set in any qualifying examination, be it in medicine or other faculty, would he be able to answer the questions set? Would the past masters of the subject—would the examiners themselves? By the form of the question Sir Joseph seems to imply a negative answer. Mr. Frederick Harrison follows in the same strain. The great protest made against examinations in 1888 has been adverted to above. It was an exceedingly bitter cry, and from the number of protestants a very loud cry. One hundred members of the British Parliament signed the protest, and of teachers a great battalion. The protest is superficially an indictment of the spoils system in education. It is fundamentally an attack upon the general tendency of our modern world towards the pursuit of wealth in association with the doctrine of quick returns. The protest says very truly that under the competitive examination system—

"The pupil allows himself to be mechanically guided for the sake of success. His mental sympathies become bounded by the narrowest horizon. What will pay? in the examination becomes his ruling

* Except the Bishop of Carlisle, in *Nineteenth Century*, Feb., 1889, p. 315.

† So also Archdeacon Browne in 1884. The statistics of the London Mat. Exam. illustrate this point. In 1859 the percentage of failure was 13. This percentage steadily rose until 1869, when it stood at 52; since that time it has remained at about 54 per cent., yet the standard of teaching was rising steadily all the decade quoted.

‡ *Nineteenth Century*, February, 1889, p. 302.

thought, and he turns away from many intellectual interests as from luxuries that must be sternly put aside for the sake of success in the all important examination." This self-denial with regard to new interests in knowledge is precisely the process which, on changing the circumstances and results, the successful father of an ambitious pupil is pursuing all day long, all the year round. The father in simple language calls it "sticking to his business." He is working for his prizes, and he does not allow himself to be distracted by new interests that may ramify away to disaster. He is aware that out of any average hundred new interests ninety-nine will lead to nothing, while he has neither time nor inclination to go out into the wilderness in search of the hundredth fruitful interest. Notwithstanding this habit of keeping a cautious eye on the main chance, such a father would no doubt have signed the protest; he thinks the spoils system in education wrong; perhaps he may consider the spoils system generally capable of improvement. But he would like to think his young people unsophisticated, vigorous with the sap of freshness coursing through their veins; that they ought to be superior to these things, and in early life give promise of brighter hopes than shine within his own horizon. So they should, but on the whole they do not. And why? Because in modern life the squeeze and jostle at the entrance of any avenue of life is greater, more strenuous, and more prolonged than it was even twenty years ago. The prizes of life have enormously increased, while the sense of defeat has also enormously increased. A boy in the stage on which childhood is rapidly vanishing and manhood is rapidly advancing soon discovers this world fact. Then there is demanded of him a virtue his seniors do not possess, and for the most part do not profess. I am reminded here of the very trenchant words of Mr. Fearon in his excellent little book on "School Inspection." He, on the subject of copying, says—

"There is only one way of making sure that copying is not practised in a school, and that is to make it impossible. It is absurd to talk as if copying could be stopped by appeals to the children's honour, or by punishment of those who are detected in the practice. The sense of honour in children in an elementary school should not be expected to be greater than that of Eton boys or undergraduates, or candidates for the civil and military services, or for holy orders. . . . (p. 57). What examinees at public schools and universities will freely do, children in elementary schools will do."

These words may apply to the great question of competition for prizes; if you would diminish the evil you must abate the temptation. When the famous protest of 1888 was made, Mr. Fred. Harrison wrote—

"We want neither distinctions, prizes, nor tests in anything like the profusion in which they are now poured out. Art, learning, politics, and amusement are deluged with shows, races, competition, and prizes. Life is becoming one long scramble of prize-winning and pot-hunting."

According to this view there is no cure for the sacrifice of education to examination but the extirpation of prizes, scholarships, and exhibitions. According to this view the founder of a scholarship, like a man who deals in indiscriminate charity, is perniciously benevolent.

With these notions I am much tempted to agree. I have long regarded scholarships and such like devices as of dubious benefit. I am inclined to think that if the value of all scholarships were fused and poured into one common pot for the reduction of the expense of higher education to individuals, then more benefit would accrue to the individual citizen through the mass than now accrues to the community through the specific few. This arrangement might mitigate the evils complained of with so much justice. I believe, of course, in getting a *quid pro quo* for all outlay, but there should be more patience in waiting for the *quid*, whilst it is possible that the highest result of all would be, in these democracies, improvement in the tone and character of the democracies themselves. Democracy without the highest education is mere blind adventure and childish experiment, involving, nevertheless, serious results. The first and natural corollary of a democracy is high education free.*

As to the machinery of examination, one may say that it has been perfected with as much ingenuity as has been brought to bear on any institution in our days. The examinations I believe to be carried on with unimpeachable fairness and thoroughness. The average results are found to be quite just and equitable. The cry of the plucked one is sometimes bitter—it is usually querulous and akin to the morning groan of him who has drunk not wisely but too well. Naturally it has been found to be good fun to pull an examiner and his papers to pieces, just as it amuses to quote absurdities from examination papers against the teachers. Humanity is indulgent to its own dulness and slowness, while it enjoys an occasional tilt at schoolmasters, examiners, clergymen, and others who endeavour to move matters along. Examination work, however, is most carefully done, and owes no man anything in this respect.† I have never heard of any case of connivance, cheating, or mismanagement in the conduct of public examinations throughout the Empire. Can anyone, for instance, bring forward a case parallel to the following reported from San Francisco, and mentioned by a speaker at an American Education Conference as being within his own experience? To show with what ease papers prepared for the examination were accessible the evening before a certain scholarship examination, the *San Francisco Bulletin* published the whole of the papers ready for setting in the competition commencing next day, with the result that the examinations had to be abandoned. The speaker goes on to say that, in consequence, the whole system of competitive scholarships was abandoned.‡ This story reveals a condition of things which within the same department of work is without parallel in the history of British examinations.

Up to this date the pressure of examinations has not been felt in the same degree in these colonies as is the case in the mother country. Grammar school education is not yet organised, while our universities are not wealthy enough to dangle tempting baits before ambitious

* Aristotle: Politics ii., ch. 5. "For a State regarded as a multitude should be brought into unity and community of feeling by education. . . . . just as in Lacedæmon property has been made common." The context clearly implies that education or, as he calls it further on, intellectual cultivation should be free.

† The late Oscar Browning at Internat. Conference on Education iii., p. 197.

‡ Amer. Bureau of Education, p. 222, Report 1889-1890.

noses. Examinations for fellowships, for the Indian and Imperial civil services, for the navy, for the army, weigh for little in our academical life. The clerical order which in Great Britain covers and controls a great deal of the examination ground, exerts in this hemisphere very slight influence. In all Australia I suppose there is no professional crammer or coach important enough to impress the imagination of the public. It should be then to Australasia, where learning is very much its own reward, and wherein no special pecuniary value attaches to academical prominence, that the protestants of 1888 should direct their eyes. Here it is a case of—*Cantabit vacuus;* the evils do not exist because there is no antecedent cause. We have nearly 4,000,000 of people who, inheritors of the experience, and taught by the mistakes of their forefathers across the sea, should follow a more excellent way.

Here the sacred torch of learning should burn high and clear, fed by the free oblations of an enlightened people.

Tormented and strained by no sworn torturers, this Egeria of ours, graceful, natural, and easy, should tread her light and airy way like some rustic Phyllis, whose charms in contrast with the faded airs of a painted and powdered city madam are so potent. Such should our Australasian Egeria do amid the meads of Asphodel, wherein the Muses sport. But does she?

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LIST OF MEMBERS

OF THE

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FOR THE YEAR ENDING JUNE, 1895.

Abbott, W. E., Abbotsford, Wingen, N.S.W.
Abraham, Jabez, State School, Hemmant, Q.
Adams, W. J., 71 Clarence street, Sydney, N.S.W.
Ahearne, Joseph, L.R.C.S., &c., Townsville, Q.
Allan, James, Messrs. Allan & Stark, Queen street, Brisbane, Q.
Allen, James, M.A., M.H.R., Clyde street, Dunedin, N.Z.
Allcutt, C. T., Agricultural Department, Brisbane, Q.
Almond, Captain T. M., F.R.A.S., Portmaster, Harbours and Rivers Department, Brisbane, Q.
Anderson, C. Morton, M.R.C.S., Colombo road, Sydenham, Christchurch, N.Z.
Anderson, Professor Francis, M.A., University, Sydney, N.S.W.
Angas, Hon. J. H., M.L.C., Collingrove, Angaston, S.A.
Annett, T. H., Imperial Hotel, George street, Brisbane, Q.
Arthur, John M., c/o. Brabant & Co., Charlotte street, Brisbane, Q.
Ashworth, Louis N., M.B., Children's Hospital, Brisbane, Q.
Austin, R. M., "Strathmore," North Quay, Brisbane, Q.
Avery, D., B.Sc., Queen's College, University, Melbourne, V.
Ayers, Sir H., G.C.M.G., F.G.S., North terrace, Adelaide, S.A.

Bagot, J., Adelaide Club, Adelaide, S.A.
Bailey, Frederick Manson, F.L.S., Colonial Botanist, Agricultural Department, Brisbane, Q.
Bailey, J. F., Agricultural Department, William street, Brisbane, Q.
Baines, A. C., Upper Riccarton, Christchurch, N.Z.
Bale, A. W., Beenleigh, Q.
Bancroft, P., M.D., Wharf street, Brisbane, Q.
Bannerman, Adam, State School, Bowen, Q.
Barlow, Right Rev. C. G., D.D., Bishop of North Queensland, Townsville, Q.
Barnard, R. J. H., A.M.A., Queen's College, Melbourne, V.
Barnes, C. H., 16 Eagle Chambers, Pirie street, Adelaide, S.A.
Barton, Charles H., B.A., Maryborough, Q.
Belcher, Rev. H., M.A., LL.D., Boys' High School, Dunedin, N.Z.
Belfield, A. H., "Eversleigh," Dumaresq, N.S.W.
Bell, C. Napier, C.E., Christchurch, N.Z.
Bennett, F., State School, Morven, Q.
Benson, A. H., Government Fruit Export Department, Sydney, N.S.W.
Berney, Augustus, 74 Alberto terrace, Darlinghurst road, Sydney, N.S.W.
Berney, Geo. Aug., 74 Alberto terrace, Darlinghurst road, Sydney, N.S.W.
Bevington, W. J., State School, Sandgate, Q.
Bick, W. C., Alfred Shaw & Co., Queen street, Brisbane, Q.
Birks, L., University, Adelaide, S.A.
Bishop, Rookwood C., Secretary Gas Company, Christchurch, N.Z.
Blake, E. C., Pharmacy Board, Brisbane, Q.
Blakemore, G. H., c/o British Broken Hill Mining Co., Broken Hill, N.S.W.
Blashki, Aaron, 169 Clarence street, Sydney, N.S.W.
Bond, Albert, Bell's Chambers, Pitt street, Sydney, N.S.W.
Bonython, J. L., Wakefield street East, Adelaide, S.A.
Booth, Jas., L.R.C.P., &c., Cordelia street, South Brisbane, Q.
Borthwick, T., M.D., Parade, Norwood, S.A.
Bowler, Patrick, State School, Newtown, Ipswich, Q.
Boyd, Major A. J., "Riviera," North Quay, Brisbane, Q.
Bradbury, Thomas, State School, Beenleigh, Q.
Bradshaw, Samuel, State School, Cooper's Plains, Brisbane, Q.
Bradshaw, W. E., Barclay street East, Ararat, V.
Brady, A. B., M.I.C.E., Engineer for Bridges, Works Department, Brisbane, Q.

Bragg, W. H., M.A., Professor of Mathematics and Natural Philosophy, University, Adelaide, S.A.
Brier, Geo. B., State School, Yeronga, near Brisbane, Q.
Brittlebank, C. C., Myrniong, V.
Brodhurst, Rev. E. H. H., M.A., St. Peters, West End, Brisbane, Q.
Brown, David, Kallara, Bourke, N.S.W.
Brown, H. J., Solicitor, Newcastle, N.S.W.
Brown, J. W., LL.D., c/o Alex. Morton, Museum, Hobart, Tas.
Buckle, Rev. Joseph, 1 Callander House, Wickham terrace, Brisbane, Q.
Budd, Thos., 137 Queen street, Brisbane, Q.
Bundey, His Honour Mr. Justice, Supreme Court, Adelaide, S.A.
Burdorff, Miss B., Gregory terrace, Brisbane, Q.
Burford, W., Glenelg, S.A.
Burns, James, Bridge street, Sydney, N.S.W.
Byram, W. J., Solicitor, Queen street, Brisbane, Q.
Byrne, W. S., M.B., Fortitude Valley, Brisbane, Q.

Caffrey, Thomas McD., Limestone Hill, Ipswich, Q.
Cameron, Donald, M.A., Grammar School, Ipswich, Q.
Cameron, J. S., Town Hall, Queen street, Brisbane, Q.
Cameron, S. S., Veterinary College, Melbourne, V.
Cameron, W. E., B.A., Grammar School, Ipswich, Q.
Campbell, Hon. Allan, M.L.C., L.R.C.P., L.F.P.S., North terrace, Adelaide, S.A.
Campbell, A. J., F.L.S., 10 Elm Grove, Armadale, V.
Campbell, Fred., Yarralumlah, Queanbeyan, N.S.W.
Campbell, Mrs. Jane, No. 2 Harris terrace, George street, Brisbane, Q.
Cape, A. J., M.A., Edgecliffe road, Sydney, N.S.W.
Card, Geo. W., Mines Department, Sydney, N.S.W.
Carson, Rev. James, Highgate Hill, South Brisbane, Q.
Carey, G. A. D., State School, Pine Mountain, Q.
Casperson, C. H., Baroona road, Milton, Brisbane, Q.
Castles, Wm., Central Chambers, Queen street, Brisbane, Q.
Castner, J. L., 130 Pitt street, Sydney, N.S.W.
Catlett, W. H., F.L.S., F.R.G.S., Burwood street, Burwood, N.S.W.
Cavenagh, F. C., Bank of Victoria, Ltd., Hamilton, V.
Chambers, C. W., Gordon Chambers, Queen street, Brisbane, Q.
Chambers, John, Mokopika, Hastings, Napier, N.Z.
Chapman, R. W., M.A., B.C.E., University, Adelaide, S.A.
Chater, A. B., Thomason, Chater, and Co., Queen street, Brisbane, Q.
Chatfield, Captain W., Good street, Granville, N.S.W.
Chilton, C., M.A., D.Sc., F.L.S., Edinburgh, N.B.
Chisholm, Edwin, M.D., Burradoo, N.S.W.
Chisholm, Wm., M.D., 139 Macquarie street, Sydney, N.S.W.
Christie, Rev. John, Waikouaiti, Otago, N.Z.
Clark, Miss Julie, "Leura," Toorâk, V.
Clark, Miss Marion, Abbotsleigh, Parramatta, N.S.W.
Clemes, F., Friends' High School, Hobart, Tas.
Cobb, N. A., Ph.D., Government Pathologist, North Sydney, N.S.W.
Coghlan, J., Glenormiston, Boulia, Q.
Colledge, J. M., Taylor and Colledge, Charlotte street, Brisbane, Q.
Colenso, Rev. W., F.R.S., F.L.S., Napier, N.Z.
Colley, D. J. K., Royal Mint, Sydney, N.S.W.
Collins, A. S., Mount Fyffe Station, Kaikoura, N.Z.
Collins, John, Mundoolun Station, *viâ* Jimboomba, Q.
Collins, J. George, Mundoolun Station, *viâ* Jimboomba, Q.
Collins, Wm., Mundoolun Station, *viâ* Jimboomba, Q.
Collison, C. N., Waymouth street, Adelaide, S.A.
Comrie, Jas., Northfield, Kurrajong Heights, *viâ* Richmond, N.S.W.
Comyn, George, M.B., Red Hill, Brisbane, Q.
Cook, W. E., M.E., Water and Sewerage Department, Pitt street, Sydney, N.S.W.
Cooper, Lilian V., L.R.C.P., L.R.C.S., L.F.P.S., George street, Brisbane, Q.
Cormack, M. H., Adelaide street, Brisbane, Q.
Cornwall, Ed. W., B.A., Grammar School, Ipswich, Q.
Cornwell, S., Australian Brewery, Bourke street, Redfern, Sydney, N.S.W.
Corrie, L. G., 206 Queen street, Brisbane, Q.
Costin, C. W., Office of Clerk of Parliament, Brisbane, Q.
Couldery, W. H., Cedar Grove, Logan River, Q.
Coutie, W. H., M.B., Warminster, Canterbury road, Petersham, near Sydney, N.S.W.
Cox, Rev. F. W., Wakefield street East, Adelaide, S.A.
Cox, Hon. Geo. H., M.L.C., Winbourn, Mulgoa, N.S.W.
Cox, Walter Gibbons, Wakefield's Buildings, Adelaide street, Brisbane, Q.
Crago, W. H., M.R.C.S., 34 College street, Hyde Park, Sydney, N.S.W.

Craig, A. W., University, Melbourne, V.
Cran, John, Millaquin, Bundaberg, Q.
Crane, A. W., 375 Pitt street, Sydney, N.S.W.
Cribb, Hon. T. B., M.L.C., Ipswich, Q.
Cribb, T. B., Ipswich, Q.
Crombie, James, M.L.A., Brisbane, Q.
Cunningham, P., Papanui road, Christchurch, N.Z.
Curran, Rev. J. M., F.G.S., 557 Elizabeth street, Sydney, N.S.W.

Dalton, W. E., Cavendish Chambers, Grenfell street, Adelaide, S.A.
Darley, C. W., M.I.C.E., Birtley Place, Elizabeth Bay road, Sydney, N.S.W.
Davenport, Sir S., K.C.M.G., Beaumont, S.A.
David, Rev. A. E., M.A., "Bishopsbourne," Milton, Brisbane, Q.
David, Prof. T. W. E., B.A., F.G.S., University, Sydney, N.S.W.
Davidson, J. Ewen, M.A., Mackay, Q.
Deane, H., M.A., M.I.C.E., Railway Department, Sydney, N.S.W.
Dempsey, J. J., State School, Junction Park, Brisbane, Q.
Dendy, Prof. Arthur, D.Sc., F.L.S., Canterbury College, Christchurch, N.Z.
Denham, A. S., Stanley street, South Brisbane, Q.
Denniston, Mr. Justice, Fendalton, Christchurch, N.Z.
De Vis, C. W., M.A., Curator, Queensland Museum, William street, Brisbane, Q.
Dicker, Rev. C. W. K., Ouse, Tas.
Dixon, S., Royal Exchange, Adelaide, S.A.
Dixon, W. A., F.C.S., Technical College, Sydney, N.S.W.
Dixson, T., M.B., 287 Elizabeth street, Hyde Park, Sydney, N.S.W.
Dobbie, A. H., Gawler Place, Adelaide, S.A.
Dobbie, A. W., Gawler Place, Adelaide, S.A.
Dobson, Edward, C.E., Hereford street, Christchurch, N.Z.
Docker, Judge E. B., M.A., Carhallen, Granville, N.S.W.
Doherty, W. M., Government Laboratory, Sydney, N.S.W.
Doran, Richard, State School, Alberton, Q.
Downs, Miss Helen E., Girls' Grammar School, Rockhampton, Q.
Drury, Lieutenant-Colonel E. R., C.M.G., Queensland National Bank, Brisbane, Q.
Dudley, Uriah, F.G.S., Box 110, Broken Hill, N.S.W.
Dunn, E. J., "Roseneath," Pakington street, Kew, V.
Dunstan, B., F.G.S., Technical College, Ultimo, Sydney, N.S.W.
Durham, H. R. P., Inspector of Police, Manning street, South Brisbane, Q

Edwards, E. E., "Bryntirion," Wickham terrace, Brisbane, Q.
Edwards, R., "Bryntirion," Wickham terrace, Brisbane, Q.
Edwards, Mrs. R., "Bryntirion," Wickham terrace, Brisbane, Q.
Ella, Rev. Samuel, "Rathmore," Petersham, Sydney, N.S.W.
Ellis, J. S. E., F.R.I.B.A., 295 Pitt street, Sydney, N.S.W.
Elmes, A. E., State School, Rocklea, Brisbane, Q.
Enright, Walter John, B.A., West Maitland, N.S.W.
Enys, J. D., F.G.S., Enys Castle, Penryn, Cornwall, England (*Life Member*).
Evans, Geo., 28 Castlereagh street, Sydney, N.S.W.
Evans, G. Essex, Toowoomba, Q.
Evans, William, Timaru, N.Z.
Exley, Arthur, State School, Allora, Q.

Faithful, R. L., M.D., L.R.C.P., 5 Lyons terrace, Hyde Park, Sydney, N.S.W.
Falkner, Edgar A., M.B., M.R.C.S., L.R.C.P., Toowoomba, Q.
Farr, C. Coleridge, B.Sc., St. Luke's Parsonage, Whitmore Square, Adelaide, S.A.
Fennelly, R., M.I.C.E., Kilmore, V.
Ferguson, James, Messrs. Watson, Ferguson, & Co., Queen street, Brisbane, Q.
Fewtrell, John, State School, Blenheim, Laidley, Q.
Field, A. W., Adelaide street, Brisbane, Q.
Fincham, J. A., M.I.C.E., late Engineer-in-Chief, Hobart, Tas.
Fisher, C. H., 8 Widows' Fund Buildings, Grenfell street, Adelaide, S.A.
Fleming, David, Mackinnon Parade, North Adelaide, S.A.
Fletcher, J. J., M.A., B.Sc., Linnean Hall, Elizabeth Bay, Sydney, N.S.W.
Foreman, J., M.R.C.S., 215 Macquarie street, Sydney, N.S.W.
Foxton, J. F. G., M.L.A., Indooroopilly, Brisbane, Q.
Francis, Hy. A., M.B., M.R.C.S., Sherwood, Brisbane, Q.
Fraser, John, LL.D., Victoria street, Randwick, Sydney, N.S.W.
Friend, Walter, 113 York street, Sydney, N.S.W.
Fryar, Wm., Inspector of Mines, Mines Department, Brisbane, Q.
Fullerton, A. Y., M.R.C.S., Wickham terrace, Brisbane, Q.

Gailey, Richard, *Courier* Buildings, Queen street, Brisbane, Q.
Gale, Albert, Technical College, Sydney, N.S.W.

Garran, R. R., B.A., Barncleuth Square, Elizabeth Bay, Sydney, N.S.W.
Garran, Miss, Barncleuth Square, Elizabeth Bay, Sydney, N.S.W.
Gault, A. H., M.R.C.S., L.R.C.P., Lower Mitcham, S.A.
Gay, W., Kangaroo Flat, V.
Geddie, Wm. Stewart, M.B., Gympie, Q.
George, Miss, Advanced School, Grote street, Adelaide, S.A.
Gibson, J. L., M.D., M.R.C.S., Wickham terrace, Brisbane, Q.
Gill, James, State School, Sherwood, Q.
Gill, Thos., The Treasury, Government Buildings, Adelaide, S.A.
Gill, Walter, Conservator of Forests, Dover street, Malvern, S.A.
Gill, Rev. W. W., LL.D., "Persica," Illawarra road, Marrickville, Sydney, N.S.W.
Goodlet, John H., Canterbury House, Ashfield, N.S.W.
Gordon, P. R., Chief Inspector of Stock, Treasury Buildings, Queen street, Brisbane, Q.
Goyder, G. W., Warrackville, Aldgate, Adelaide, S.A.
Graham, W. Edward, "Highlands," Albion, near Brisbane, Q.
Grasby, W. Catton, Agricultural College, Roseworthy, S.A.
Gray, Rev. W., Weasisi, Tanna, New Hebrides.
Greenelsh, J., State School, Winton, Q.
Gregory, Hon. A. C., C.M.G., M.L.C., Rosalie, Brisbane, Q.
Gregory, E., Government Printer, William street, Brisbane, Q.
Greville, Hon. Edward, M.L.C., 374 George street, Sydney, N.S.W.
Grieve, Robert, G.P.O., Brisbane, Q.
Grieve, Mrs. Robert, G.P.O., Brisbane, Q.
Griffith, Sir Samuel W., G.C.M.G., Chief Justice, "Merthyr," New Farm, Brisbane, Q.
Gronow, W. T., Smelting Works, Port Pirie, S.A.
Groom, L. E., M.A., LL.M., Town Hall Chambers, Queen street, Brisbane, Q.
Grut, P. De Jersey, English, Scottish, and Australian Bank, Edward street, Brisbane, Q.
Gullett, Henry, *Sydney Morning Herald* Office, Pitt street, Sydney, N.S.W.

Hales, H. V., Zeehan, Tas.
Hall, Sir John, K.C.M.G, Hororata, Canterbury, N.Z.
Hall, T. S., M.A., Biological School, University, Melbourne, V.
Hamlet, W. M., F.C.S., F.I.C., Government Analyst, Treasury Buildings, Sydney, N.S.W.
Hammond, H. W., Burwood Heights, Burwood, N.S.W.
Hancock, H. L., Moonta Mines, S.A.
Hardie, D., M.B., Byrne Terrace, Wickham terrace, Brisbane, Q.
Hargrave, Lawrence, Stanwell Park, Clifton, N.S.W.
Hargreaves, W. A., M.A., B.C.E., Manning street, South Brisbane, Q.
Harris, Rev. E., D.D., King's School, Parramatta, N.S.W.
Harris, Alderman John, Town Hall, Sydney, N.S.W.
Harrison, G. R., Beecroft, N.S.W.
Hartley, J. A., B.A., B.Sc., Balliol street, College Town, S.A.
Hartley, Stewart W., *Bulletin* Office, Rockhampton, Q.
Harvey, J. H., 127 Gipps street, East Melbourne, V.
Haswell, Prof. W. A., M.A., D.Sc., F.L.S., University, Sydney, N.S.W.
Hattam, Miss Laura, Forest street, Bendigo, V.
Hawker, E. W., M.A., M.P., Robe terrace, Medindie, S.A.
Hawker, Hon. G. C., M.P., The Briars, Medindie, S.A.
Hay, Alex., J.P., "Linden," Burnside, S.A.
Haycroft, J. T., M.E., Ocean street, Woollahra, Sydney, N.S.W.
Heath, Walter, M.A., Taringa, near Brisbane, Q.
Hector, Sir James, M.D., K.C.M.G., F.R.S., Wellington, N.Z.
Hedley, Charles, F.L.S., Australian Museum, Sydney, N.S.W.
Henderson, James, City Bank, George street, Sydney, N.S.W.
Henderson, J. Brownlie, Government Analyst, William street, Brisbane, Q.
Higgins, Geo., Colonial Mutual Chambers, 421 Collins street, Melbourne, V.
Hill, J., M.D., North Quay, Brisbane, Q.
Hirschfeld, Eugen, M.D., Wickham terrace, Brisbane, Q.
Hocken, T. M., M.R.C.S., F.L.S., Moray Place, Dunedin, N.Z.
Hockings, P. F., A.F.R.I.B.A., Montague road, South Brisbane, Q.
Hodges, Charles H., M.A., Grammar School, Townsville, Q.
Hogben, George, M.A., High School, Timaru, N.Z.
Hogg, E. G., M.A., Trinity College, Melbourne, V.
Hogg, H. R., Market Buildings, Melbourne, V.
Hoggins, Rev. A. C., B.A., Ithaca, Brisbane, Q.
Holdaway, E., State School, Laidley North, Q.
Hollidge, D. H., M.A., Way College, Unley, S.A.
Holroyd, Mr. Justice, "Fernacres," Alma road, East St. Kilda, V.
Holt, F. S. E., "Ronleigh," Church street, Burwood, N.S.W.
Holtze, M. O., F.L.S., Botanic Gardens, Adelaide, S.A.

Howchin, Walter, F.G.S., Essex street, Goodwood, S.A.
Hume, J. K., Beulah, Campbelltown, N.S.W.
Hunt, Miss F. E., B.Sc., Girls' Grammar School, Ipswich, Q.
Hunt, James S., L.R.C.P., M.R.C.S., Hughenden, Q.
Hutchinson, W. A., Bond street, Sydney, N.S.W.
Hutton, Capt. F. W., F.R.S., Canterbury Museum, Christchurch, N Z

Illidge, R., Commercial Insurance Co., Queen street, Brisbane, Q.
Ingram, Alex., Hamilton, V.
Irvine, G. H., Johnsonian Buildings, Elizabeth street, Brisbane, Q.
Irving, James, M.R.C.V.S.L., Ann street, Brisbane, Q.

Jack, R. L., F.G.S., F.R.G.S., Geological Survey Office, Brisbane, Q.
Jack, Mrs. R. L., Jordan terrace, Breakfast Creek road, Brisbane, Q.
Jack, Wm., Messrs. Jack & Mackenzie, Queen street, Brisbane, Q.
Jackson, W. H., Messrs. Finney, Isles, & Co., Brisbane, Q.
Jacob, A. F., Birkbeck, Fairfield, N.S.W.
James, Miss H. S., 4 Kildare Terrace, Spencer street, Summer Hill, *viâ* Sydney, N.S.W.
James, T., M.D., Moonta, S.A.
Jamieson, M. B., 31 Queen street, Melbourne, V.
Jenkins, Capt. J. E., Survey Office, Ararat, V.
Jensen, Magnus, Ruthning & Jensen, Solicitors, Queen street, Brisbane, Q.
Jones, Daniel, Redbank, Q.
Jones, E. L., Brickley, Burwood, N.S.W.
Jones, J. E., State School, Leichhardt street, Brisbane, Q.
Jones, P. Sydney, M.D., F.R.C.S., 16 College street, Hyde Park, Sydney, N.S.W.
Josephson, J. Percy, C.E., George street, Upper Marrickville, Sydney, N.S.W.

Kater, Hon. H. E., M.L.C., "Cheverells," Elizabeth Bay road, Sydney, N.S.W
Kaye, W. C., Queen street, Brisbane, Q.
Kayser, F., Mount Bischoff, Tas.
Kebbell, W., M.R.C.S., &c., Stanley street, South Brisbane, Q.
Keep, John, Broughton Hall, Leichhardt, Sydney, N.S.W.
Kelly, Rev. Robert, Essex street, Goodwood, S.A.
Kelly, T. H., 14 O'Connell street, Sydney, N.S.W.
Kent, H. C., Bell's Chambers, Pitt street, Sydney, N.S.W.
Kerby, T. G., State School, Nanango, Q.
Kernot, Prof. W. C., M.A., C.E., University, Melbourne, V.
Kerr, James S., Central State School, Edward street, Brisbane, Q.
Keys, James, State School, South Bundaberg, Q.
Kiddle, Hugh Chas., Public School, Seven Oaks, *viâ* Smithtown Macleay River, N.S.W.
King, E. M., Launceston, Tas.
King, Miss Georgina, Beresford road, Homebush, N.S.W.
King, Hon. P. G., M.L.C., "Banksia," William street, Double Bay, Sydney, N.S.W.
King, S., c/o Alex. Morton, Museum, Hobart, Tas.
Kingsbury, J. J., M.L.A., c/o Messrs. Beale & Co., Queen street, Brisbane, Q.
Knaggs, Samuel T., F.R.C.S., M.D., 16 College street, Hyde Park, Sydney, N.S.W.
Knibbs, George H., "Avoca," Denison road, Petersham, Sydney, N.S.W.
Knox, Hon. Edward, M.L.C., "Fiona," Double Bay, Sydney, N.S.W.
Knox, E. W., "Rona," Belle Vue Hill, Sydney, N.S.W.
Kortum, Axel H. F. B., M.D., Cooktown, Q.

Lamond, Rev. John L., "Merina," Clayfield, Q.
Lamont, Rev. J., F.L.S., The Manse, Kogara, N.S.W.
Lang, Gilbert, Queen street, Brisbane, Q.
Latta, Miss, "Mountsea," Burlington road, Homebush, N.S W.
Lauterer, Joseph, M.D., Vulture street, South Brisbane, Q.
Lavery, Hugh, Survey Office, Benalla, V.
Lawes, C. H. E., M.B., Hospital, Brisbane, Q.
Learmonth, Harold, Hamilton, V.
Le Souëf, D., Zoological Society, Parkville, Melbourne, V.
Lethem, C. B., Clayfield, Brisbane, Q.
Lidgey, Ernest, 32 Lydiard street, Ballarat, V.
Lilley, Hon. Sir Chas., Kt., Gregory terrace, Brisbane, Q.
Lingen, J. T., M.A., 89 Elizabeth street, Sydney, N.S.W.
Little, J. H., M.B., Wickham terrace, Brisbane, Q.
Liversidge, Prof. A., M.A., F.R.S., University, Sydney, N.S.W.
Lloyd, J. S., Lefevre terrace, N. Adelaide, S.A.
Lodder, Miss, The Leven, Tas.
Longlands, Miss, Commercial road, Bulimba, Q.

Louch, J. E., c/o Mr. G. A. Louch, 26 Compagne Gardens, South Hampstead, London, N.W.
Love, E. F. J., M.A., Queen's College, University, Melbourne, V.
Love, Wilton W. R., M.B., Wickham terrace, Brisbane, Q.
Lowrie, Prof., B.Sc., Agricultural College, Roseworthy, S.A.
Lucas, R. B., senr., Warden of Government Standards, Unley road, Adelaide, S.A.
Lucas, Thomas P., L.R.C.P., Stanley street, South Brisbane, Q.
Lucken, Wm., 206 Queen street, Brisbane, Q.

Macdonald, A. C., Royal Geographical Society, Melbourne, V.
Macdonald, Mrs. Margaret R., 70 Queen street, Melbourne, V.
Mackay, Angus, F.G.S., Technical College, Sydney, N.S.W.
Mactaggart, D., Wakefield's Buildings, Adelaide street, Brisbane, Q.
MacKellar, Hon. C. K., M.L.C., M.B., Ch.M., "Dunara," Rose Bay, Sydney, N.S.W.
Madden, P., State School, No. 253 Upper Footscray, V.
Maddrell, R., "Bedervale," Braidwood, N.S.W.
Madsen, H. F., Hessélind House, Queen street, Newtown, Sydney, N.S.W.
Maiden, J. H., F.C.S., F.L.S., Technological Museum, Sydney, N.S.W.
Mair, C. C., Graceville, Q.
Maitland, A. Gibb, Geological Survey Office, Brisbane, Q.
Manning, Hon. Sir Wm., M.L.C., LL.D., &c., Woollahra, Sydney, N.S.W.
Mansfield, E., Town Hall Chambers, Brisbane, Q.
Mant, C. O., Dalgety & Co., Elizabeth street, Sydney, N.S.W.
Marks, P. J., 80 Victoria street, North Darlinghurst, Sydney, N.S.W.
Martin, Hon. Jas., Gawler, S.A.
Martin, Mrs. W., Drouin, V.
Maughan, Milton M., Whitmore Square, Adelaide, S.A.
Maxwell, J. P., C.E., Wellington, N.Z.
Meadows, Dr. H. J., Christchurch, N.Z.
Meston, A., Sussex street, South Brisbane, Q.
Milford, F., M.D., M.R.C.S., 3 Clarendon Terrace, Elizabeth street, Sydney, N.S.W.
Milford, K., 37 Queen street, Brisbane, Q.
Miller, Robt., 72 Clarence street, Sydney, N.S.W.
Milne, Mrs. W. J., "Byethorn," Mount Lofty Station, S.A.
Milson, Jas., "Elamang," St. Leonards, Sydney, N.S.W.
Mingaye, J. C. H., F.C.S., Mines Department, Sydney, N.S.W.
Molineaux, A., F.L.S., F.R.H.S., Kent terrace, Kent Town, S.A.
Moncrieff, A. B., M.I.C.E., Engineer-in-Chief, Trinity street, College Town, S.A.
Moore, A. E., State School, Laidley South, Q.
Moran, His Eminence Cardinal, St. Mary's Cathedral, Sydney, N.S.W.
Morehead, Hon. B. D., M.L.A., Bowen Hills, Brisbane, Q.
Morris, W. F., F.P.S.G., F.R.M.S.L., 5 Bligh street, Sydney, N.S.W.
Morris, Rev. Wm., Bundaberg, Q.
Morton, Alex., F.L.S., Museum, Hobart, Tas.
Morton, H. G., "Numba," Shoalhaven, N.S.W.
Mosman, Hon. Hugh, M.L.C., Parliament House, Brisbane, Q.
Mueller, Baron F. von, K.C.M.G., Arnold street, South Yarra, V.
Mullens, Josiah, F.R.G.S., "Tenilba," Burwood, N.S.W.
Muller, Charles F., Gladstone, Q.
Mullins, Geo. Lane, M.D., Sydney, N.S.W.
Munday, John, Kangaroo Point, Brisbane, Q.
Murdoch, Geo. D., Hopetown, V.
Murnin, M. E., Eisenfels, Nattai, N.S.W.
Murray, D., Gawler Place, Adelaide, S.A.

McAlpine, D., Agricultural Department, Melbourne, V.
McAulay, Alexander, M.A., Bellerive, Hobart, Tas.
McConnel, Eric, Mount Brisbane Station, near Esk, Q.
McConnel, Jas. H., Cresbrook Station, near Esk, Q.
McClymont, J. R., c/o Alex. Morton, Museum, Hobart, Tas.
McClymont, Miss, Wyalla, Nanango, Q.
McDonnell, Æneas J., M.B., M.S., Toowoomba, Q.
McDowall, Archibald, Surveyor-General, Brisbane, Q.
McIlwraith, W., *Bulletin* Office, Rockhampton, Q.
McIntyre, R. B., State School, Lytton, Q.
McKechnie, Chas., Barker street, New Farm, Brisbane, Q.
McKiernan, Rev. M. J., St. Patrick's, Fortitude Valley, Brisbane, Q.
McLaurin, Hon. H. N., M.L.C., M.A., M.D., &c., 125 Macquarie street, Sydney, N.S.W.
McLean, Peter, Under Secretary, Agricultural Dept., William street, Brisbane, Q.
McLeod, J. A., State School, One-Mile, Gympie, Q.

McMahon, Philip, Curator, Botanic Gardens, Brisbane, Q.
McPherson, Hon. Peter, M.L.C., Montague road, S. Brisbane, Q.
McSwaine, Rev. J. F., F.E.I.S., Leichhardt street, Brisbane, Q.

Nelson, Hon. Hugh M., M.L.A., Treasury Buildings, Brisbane, Q
Nicholson, John H., c/o J. D. Franz, Nundah, Q.
Nicoll, J. R., M.B., Goodna, Q.
Niesche, F. W., M.D., C.M., Franklin street, Adelaide, S.A.
Noble, J. J., "Mountview," Red Hill, Brisbane, Q.
Nolan, H. Russell, M.B., Russell street, Toowoomba, Q.
Norman, His Excellency Sir Hy. W., G.C.M.G., Government House, Brisbane, Q.
Norton, Hon. Albert, M.L.C., Fernberg road, Milton, Brisbane, Q.
Norton, Albert Jas., Fernberg road, Milton, Brisbane, Q.
Norton, Hon. James, M.L.C., LL.D., 2 O'Connell street, Sydney, N.S.W.

O'Connor, D., "Duporth," Oxley, Q.
O'Doherty, Edw. H., M.R.C.S.I., Wickham terrace, Brisbane, Q.
O'Doherty, Kevin Izod, F.R.C.S.I., Queen street, Brisbane, Q.
O'Grady, T. R., Whiteman Creek, Grafton, N.S.W.
O'Hara, John B., M.A., South Melbourne College, V.
Orr, A. W., M.B., Australian Mutual Chambers, Brisbane, Q.
Owen, David, Austral Chambers, Queen street, Brisbane, Q.
Owen, E. Lloyd, Limestone Hill, Ipswich, Q.

Parker, Prof. T. J., D.Sc., F.R.S., &c., Otago University, Dunedin, N.Z.
Parkes, J. V., Inspector of Mines, off Commercial road, Hyde Park, Adelaide, S.A.
Parkhouse, A. T., Henley Beach, S.A.
Paterson, Alex., Lake's Creek, Rockhampton, Q.
Paterson, Hugh, 6 Lyons terrace, Hyde Park, Sydney, N.S.W.
Peacock, Caleb, Adelaide Club, Adelaide, S.A.
Petrie, Thos., North Pine, Q.
Pharazyn, C., Wellington, N.Z.
Phillips, Coleman, Featherston, Williamstown, N.Z.
Phillips, L., c/o Moss and Co., Box 250, G.P.O., Sydney, N.S.W.
Phillips, W. H., Glenelg, S.A.
Piguenit, W. C., "Saintonge," Hunter's Hill, Sydney, N.S.W.
Piper, W. S., editor *Chemist and Druggist of Australasia*, Melbourne, V.
Pitt, G. M., Pastoral Chambers, George street, Sydney, N.S.W.
Pittman, E. F., A.R.S.M., F.G.S., Mines Department, Sydney, N.S.W.
Platt, J., Senior District Inspector of Schools, Water street, South Brisbane, Q.
Plummer, John, Box 413, G.P.O., Sydney, N.S.W.
Pockley, F. A., M.B., M.R.C.S., St. Leonard's House, Miller street, North Sydney, N.S.W.
Pollock, J. Arthur, Demonstrator in Physics, The University, Glebe, Sydney, N.S.W.
Pollock, Rev. J. S., Sherwood, Q.
Poole, Rev. Canon, M.A., St. John's Parsonage, Adelaide, S.A.
Pound, C. J., Stock Institute, Brisbane, Q.
Power, Geo. W., M.A., LL.M., Town Hall, Brisbane, Q.
Powers, Chas., M.L.A., Town Hall Chambers, Brisbane, Q.
Prankerd, P. D., c/o Italian Consulate, Pirie street, S.A.
Pritchard, C., Milton, Brisbane, Q.
Pritchard, G. B., 22 Mantell street, Moonee Ponds, V.
Proctor, J. F., Union Bank, Adelaide, S.A.
Prosser, E., Porthamel, Darling Point, Sydney, N.S.W.
Pye, T., Colonial Architect's Department, Brisbane, Q.
Pyne, Capt., A.D.C., Government House, Brisbane, Q.

Quick, John, LL.D., Bendigo, V.
Quick, Mrs. John, Bendigo, V.

Radcliffe, Oliver, State School, Breakfast Creek, Q.
Rae, John, 278 Liverpool street, Darlinghurst, Sydney, N.S.W.
Raff, A. C., Corinda, Q.
Rands, W. H., Geological Survey Office, Brisbane, Q.
Rattray, Jas., Dunedin, N.Z.
Raymond, Miss M. S., Grammar School, Brisbane, Q.
Reid, G. C., Albion Station road, Albion, Q.
Relton, R. H., Perkins and Co., Mary street, Brisbane, Q.
Rennie, E. H., D.Sc., Professor of Chemistry, University, Adelaide, S.A.
Richardson, R. P., The Lodge, Moss Vale, N.S.W.
Riley, Hon. A. J., Burwood, N.S.W.
Ringrose, R. C., M.A., Herberton, Q.

Rivers, Rev. A. R., M.A., St. Andrew's, South Brisbane, Q.
Rivers, R. Godfrey, School of Arts, Ann street, Brisbane, Q.
Roberts, Sir Alfred. M.R.C.S., 147 Macquarie street, Sydney, N.S.W
Roberts, Rev. R. Hy., Enoggera terrace, Brisbane, Q.
Roberts, Rev. Walter, M.A., New Farm, Brisbane, Q.
Robertson, James, Maryborough, Q.
Rochford, Jas., C.E., Napier, N.Z.
Roe, R. H., M.A., Grammar School, Brisbane, Q.
Ross, W. J. Clunies, B.Sc., "Calluna," Lambert street, Bathurst, N.S.W.
Ross, Mrs. Clunies, "Calluna," Lambert street, Bathurst, N.S.W
Rowe, T., Vickery's Buildings, Pitt street, Sydney, N.S.W.
Rowney, Sinclair, 133 Queen street, Brisbane, Q.
Roy, Gilbert M., Librarian, Supreme Court, Brisbane, Q.
Rule, Jas., Inspector of Schools, Hobart, Tas.
Russell, H. C., C.M.G., B.A., &c., Observatory, Sydney, N.S.W.
Russell, Wm., Private Observatory, Semaphore, S.A.
Rüthning, H. L. E., Solicitor, Cordelia street, South Brisbane, Q.
Ryan, J. P., L.R.C.P., &c., Gympie, Q.

Sach, Albert J., F.C.S., Technical School, Goulburn, N.S.W.
Sager, E., 127 Macquarie street, Sydney, N.S.W.
Salter, A. E., M.B., Thursday Island, Q.
Sankey, J. R., Queen street, Brisbane, Q.
Schacht, Hy., B.A., 150 Queen street, Brisbane, Q.
Schofield, J.A., A.R.S.M., F.C.S., University, Sydney, N.S.W.
Scott, George, M.A., Town Hall Chambers, Queen street, Brisbane, Q.
Scott, Hon. H., M.L.C., Glen Osmond, S.A.
Scott, Prof. J. H., M.D., University, Dunedin, N.Z.
Scott, Prof. Walter, M.A., University, Sydney, N.S.W.
Scott, Walter, District Inspector of Schools, East Brisbane, Q.
Shaw, P. W., C.E., "Liswell," Torrington road, Strathfield, N.S W.
Shand, Prof., LL.D., University, Otago, N.Z.
Shea, Daniel, State School, Waterford, Q.
Shea, Michael L., State School, Winton, Q.
Shea, Patrick, State School, Homebush, Mackay, Q.
Shea, Thomas, Waterford, Q.
Shelton, E. M., M.Sc., Agricultural Department, Brisbane, Q.
Shellshear, W., M.Ins.C.E., Goulburn, N.S.W.
Sheridan, R. B., George street, Brisbane, Q.
Shepherd, F. H. (c/o A. O. Herbert, Fernberg road, Milton), Charleville, Q.
Shirley, John, B.Sc., Cordelia street, South Brisbane, Q.
Shorter, John, Box 469, G.P.O., Sydney, N.S.W.
Shugg, James, Castlemaine, V.
Simmonds, F. W., Toowong, near Brisbane, Q.
Simmonds, J. H., Roma street, Brisbane, Q.
Simmons, Rev. H., Rectory, Woolloongabba, South Brisbane, Q.
Simpson, Hon. A. M., M.L.C., Parliament House, Adelaide, S.A.
Simson, Augustus, Launceston, Tas.
Simson, Mrs. R., Leura, Toorak, V.
Skelton, Richard, State School, Rosevale, Q.
Slater, M., Woodhill, Logan River, Q.
Smeaton, Thos. D., Blakiston, Littlehampton, S.A.
Smith, Alex. D. (c/o D. L. Brown, Eagle street, Brisbane, Q.), Glasgow, Scotland.
Smith, Jas., "Blinkbonny," Albert Park, V.
Smith, J McGarvie, Denison street, Woollahra, Sydney, N.S.W.
Smith, P., M.D., Dunwich, Q.
Smith, Robert Harrison, M.L.A., Bowen, Q.
Smith, S. Percy, F.R.G.S., Wellington, N.Z.
Smith, Most Rev. W. S., Lord Bishop of Sydney, Macleay street, Sydney, N.S.W.
Snow, F. H., 29 Grenfell street, Adelaide, S.A.
Soutter, Wm., Acclimatisation Society, Bowen Park, Brisbane, Q.
Spenser, Prof. W. Baldwin, M.A., University, Melbourne, V.
Spiers, James, State School, Toowoomba East, Q.
Springthorpe, J. W., M.A., M.D., &c., Collins street East, Melbourne, V.
Stanley, H. C., M.Inst.C.E., Engineer-in-Chief of Railways, Q.
Statham, E. J., "Fenella," Frederick street, Rockdale, N.S.W.
Steane, S. A., District Survey Office, Hay, N.S.W.
Stephens, J. Brunton, Water street, South Brisbane, Q.
Stephen, His Hon. Mr. Justice, Supreme Court, Sydney, N.S.W.
Stevens, Miss J. E., Girls' Collegiate School, Flinders street, Adelaide, S.A.
Stewart, Hon. John, M.L.C., Summerhill, N.S.W.
Stewart, H. R., Launceston, Tas.

St. Ledger, Anthony J., Barrister, Chancery Chambers, George street, Brisbane, Q.
Stone-Wigg, Rev. M. J., M.A., William street, Brisbane, Q.
Stonier, George A., 26 Wellington street, Newtown, Sydney, N.S.W.
Strawbridge, W., Surveyor-General, Adelaide, S.A.
Stuart, Prof. T. P. Anderson, M.D., University, Sydney, N.S.W.
Sugden, Edward H., Queen's College, Melbourne, V.
Sulman, John, F.R.I.B.A., Wynyard street, Sydney, N.S.W.
Sutherland, Rev. A. C., M.A., Junction road, Port Adelaide, S.A.
Sutton, A., M.R.C.S., Beenleigh, Q.
Sutton, J. W., Kangaroo Point, Brisbane, Q.
Sweet, G., The Close, Brunswick, Melbourne, V.
Synan, M., State School, South Brisbane, Q.

Tate, Ralph, F.G.S., F.L.S., Professor of Natural Science, University, Adelaide, S.A.
Taylor, Hon. W. F., M.D., M.L.C., Edward street, Brisbane, Q.
Teague, Rev. H. H., Clare, S.A.
Teece, R., 87 Pitt street, Sydney, N.S.W.
Tennant, J. S., B.A., Dunedin, N.Z.
Tepper, J. G. O., Museum, North terrace, Adelaide, S.A.
Thiele, H. H., Nansori, Fiji.
Thistlethwayte, D. S., Clayfield, Brisbane, Q.
Thomas, H., Chemist, Croydon, Q.
Thomas, W. Duncan, M.B. Lond., Bundaberg, Q.
Thomas, W. M., Harrow road, Auburn, Sydney, N.S.W.
Thomas, W. M., Hobart, Tas.
Thompson, J. A., M.D., 127 Macquarie street, Sydney, N.S.W.
Thompson, J. H., George street, Brisbane, Q.
Thomson, Dugald, Box 116, G.P.O., Sydney, N.S.W.
Thomson, G. M., F.L.S., Dunedin, N.Z.
Thomson, Jas., M.A., Grammar School, Maryborough, Q
Thomson, J. P., G.P.O., Brisbane, Q.
Thomson, John, M.B., Wickham terrace, Brisbane, Q.
Thornber, Miss, Unley Park, S.A.
Thorne, Ebenezer, Highgate Hill, South Brisbane, Q.
Thorp, C. G., M.B., Gladstone, Q.
Thorpe, James, Coutts street, Bulimba, Brisbane, Q.
Thow, W., Locomotive Dept., Eveleigh, Sydney, N.S.W.
Threlfall, Prof. R., M.A., University, Sydney, N.S.W.
Thynne, Hon. A. J., M.L.C., Highgate Hill, South Brisbane, Q.
Tilley, Miss M., 16 Toxteth road, Glebe Point, Sydney, N.S.W.
Tilley, Wm. J., M.R.C.S., M.B., Warwick, Q.
Tilly, Miss, Hardwicke College, St. Peter's, S.A.
Tilly, Miss L. A., Hardwicke College, St. Peter's, S.A.
Torr, W. G., B.A., LL.D., Way College, Unley, S.A.
Townson, J. E. W., Registrar of Titles' Office, Brisbane, Q.
Trackson, Jas. (Trackson Bros., Electricians), Adelaide street, Brisbane, Q.
Tryon, Henry, Government Entomologist, William street, Brisbane, Q.
Tucker, Rev. Canon Horace F., S. Yarra, V.
Tullock, L., Launceston, Tas.
Turnbull, T., F.R.I.B.A., Wellington, N.Z.
Turner, A. J. (Turner & Strong), 43 Queen street, Brisbane, Q.
Turner, Fred., F.R.H.S., Agricultural Department, Sydney, N.S.W.

Uffindell, H. W., Ellen street, Moonta, S.A.

Valentine, C. J., Wellington Square, North Adelaide, S.A.
Verco, Jos. C., M.D., North terrace, Adelaide, S.A.
Vicars, James, M.Inst.C.E., City Engineer, Adelaide, S.A.
Vickery, Hon. E., M.L.C., "Edina," Waverley, Sydney, N.S.W.
Voss, F. H. Vivian, F.R.C.S., "Penmaen," Bolsover street, Rockhampton, Q.
Voss, Mrs. F. H. V., "Penmaen," Bolsover street, Rockhampton, Q.

Walker, Edgar W., New Zealand Buildings, Queen street, Brisbane, Q.
Walker, Mrs. Janet, Wood street, South Brisbane, Q.
Walker, J. T., Waltham Buildings, Bond street, Sydney, N.S.W. (*Life Member*).
Walker, W., Railway Offices, Spencer street, Melbourne, V.
Walsh, Rev. W. M., St. Joseph's, Townsville, Q.
Walton, T. W., B.Sc., F.C.S., Colonial Sugar Co., Sydney, N.S.W.
Warren, John, Block 10 Company, Broken Hill, N.S.W.
Watkins, G., Chemist, 135 Queen street, Brisbane, Q.
Watson, C. A. H., State School, Bundamba Lower, Q.
Watson, Hon. J., M.L.C., "Glanworth," Darling Point, Sydney, N.S.W.

Waugh, J. N., M.D., North Quay, Brisbane, Q.
Way, His Hon. Chief Justice, D.C.L., Supreme Court, Adelaide, S.A.
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Weetman, Sidney, Blenheim, N.Z.
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Wheatley, T. A., Way College, Unley, S.A.
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Wilshire, Mrs., "Coolooli," Shell Cove, Sydney, N.S.W.
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Woolrych, F. B. W., "Verner," Grosvenor street, Croydon, Sydney, N.S.W.
Worsnop, Thomas, Town Hall, Adelaide, S.A.
Worsnop, Miss M. A., c/o T. Worsnop, Town Hall, Adelaide, S.A.
Wragge, Clement L., Government Meteorologist, Queen street, Brisbane, Q.
Wright, Fred., Italian Consulate, Pirie street, Adelaide, S.A.
Wright, H. Cecil, B.A., Judge's Associate, Supreme Court, Brisbane, Q.
Wright, H. G. A., M.R.C.S., Wynyard Square, Sydney, N.S.W.
Wright, John, C.E., Chief Engineer for Railways, Philip street, Sydney, N.S.W.
Wright, Robt., 4 York street, Sydney, N.S.W.

Yaldwyn, Wm., P.M., "The Poplars," North Quay, Brisbane, Q.
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