REPORT

OF THE

TENTH ANNUAL MEETING OF THE

SOUTH AFRICAN ASSOCIATION

FOR THE ADVANCEMENT OF SCIENCE.

PORT ELIZABETH,
1912.

JULY 1—5.

CAPE TOWN:
PUBLISHED BY THE ASSOCIATION.

1913.

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LIST OF PLATES.

OFFICERS AND COUNCIL, 1911-1912.

HONORARY PRESIDENT.

HIS MAJESTY THE KING.

PRESIDENT.

ARNOLD THEILER, C.M.G., D.Sc.

EX-PRESIDENT.

Prof. P. D. HAHN, M.A., Ph.D.

VICE-PRESIDENTS.

L. Crawford, M.A., D.Sc., F.R.S.E., Professor of Pure Mathematics, South African College, Cape Town.
J. Moir, M.A., D.Sc., F.C.S., Chemist to the Department of Mines, Johannesburg.
A. J. C. Molyneux, F.G.S., F.R.G.S., Bulawayo.
W. Arnott, Manager of the Gas Works, Port Elizabeth.

HON. GENERAL SECRETARIES.

R. T. A. Innes, F.R.A.S., Meteorological Observatory, Johannesburg.
C. F. Juritz, M.A., D.Sc., F.I.C., Government Analytical Laboratory, Cape Town.

HON. GENERAL TREASURER.

A. Walsh, P.O. Box 39, Cape Town.

ASSISTANT GENERAL SECRETARIES.

W. Versfeld, B.A., B.Sc. } Cape of Good Hope Savings Bank Buildings, St. George's
G. F. Britten, B.A. } Street, Cape Town.
P.O. Box 1497. (Telegraphic Address: "Scientific.")

ORDINARY MEMBERS OF COUNCIL.

I. TRANSVAAL.

Witwatersrand.

P. Cazalet.
E. A. E. Collins.
W. Cullen.
F. Flowers, C.E., F.R.A.S., F.R.G.S.
J. A. Foote, F.G.S., F.E.I.S.
A. Heymann, M.Ph., M.Ch., M.A.
Prof. J. Orr, B.Sc., A.M.I.C.E.
Prof. G. H. Stanley, A.R.S.M., M.I.M.M., F.I.C.
Prof. J. A. Wilkinson, M.A., F.C.S.
H. E. Wood, M.Sc., F.R.Met.Soc.

Pretoria.

W. E. C. Clarke, M.A.
A. L. Hall, B.A., F.G.S.
G. W. Herdman, M.A., M.I.C.E.

Potchefstroom.

A. Holm.

II. CAPE PROVINCE.

Cape Peninsula.

A. J. Anderson, M.A., M.B., D.P.H., M.R.C.S.
Prof. J. C. Beattie, D.Sc., F.R.S.E.
Rev. W. Flint, D.D.
Prof. R. Marloth, M.A., Ph.D.
Prof. H. H. W. Pearson, M.A., Sc.D., F.L.S.
A. H. Reid, F.R.I.B.A., F.R.San.I.

Port Elizabeth.

J. C. H. Brincker.
E. G. Bryant, B.A., B.Sc.
Rev. F. W. Flack, M.A., B.D.
Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.
W. A. Way, M.A.

Kingwilliamstown.

A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E.

Grahamstown.

Prof. A. Ogg, M.A., B.Sc., Ph.D.

Kimberley.

A. H. Watkins, M.D., M.R.C.S., M.L.A.

Queenstown.

W. B. Brown, M.A.

Stellenbosch.

Prof. B. de St. J. van der Riet, M.A., Ph.D.

East London.

G. Rattray, M.A., D.Sc., F.R.G.S.

III. ORANGE FREE STATE.

Bloemfontein.

Dr. W. Johnson, L.R.C.S., L.R.C.P.
C. C. Robertson, M.F.
Prof. W. A. D. Rudge, M.A.

IV. NATAL.

Pietermaritzburg.

Prof. E. Warren, D.Sc.

Durban.

A. McKenzie, M.D., C.M., M.R.C.S.

V. RHODESIA.

Bulawayo.

Franklin White, M.I.M.M.

Salisbury.

G. N. Blackshaw, B.Sc., F.C.S.

VI. BASUTOLAND.

Rev. E. Jacottet.

CONSTITUTION

OF THE

South African Association for the Advancement of Science.

[*As Amended at the Ninth Annual Meeting at Bulawayo, 1911*].

(*Words proposed by the Tenth Annual Meeting at Port Elizabeth to be omitted are printed in italics and placed between square brackets.* WORDS PROPOSED TO BE ADDED ARE PRINTED IN CAPITALS.

I.—OBJECTS.

The objects of the Association are:—To give a stronger impulse and a more systematic direction to scientific enquiry; to promote the intercourse of societies and individuals interested in Science in different parts of South Africa; to obtain a more general attention to the objects of pure and applied Science, and the removal of any disadvantages of a public kind which may impede its progress.

II.—MEMBERSHIP.

(*a*) All persons interested in the objects of the Association are eligible for Membership.

(*b*) The Association shall consist of (a) Life Members, (b) Ordinary Members (both of whom shall be included under the term "Members"), and (c) Temporary Members, elected for a session, hereinafter called "Associates."

(*c*) Members and Associates shall be elected directly by the Council, but Associates may also be elected by Local Committees. Members may also be elected by a majority of the Members of Council resident in that centre at which the next ensuing session is to be held.

(*d*) The Council shall have the power, by a two-thirds vote, to remove the name of anyone whose Membership is no longer desirable in the interests of the Association.

III.—PRIVILEGES OF MEMBERS AND ASSOCIATES.

(*a*) Life Members shall be eligible for all offices of the Association, and shall receive gratuitously all ordinary publications issued by the Association.

(*b*) Ordinary Members shall be eligible for all offices of the Association, and shall receive *gratuitously* all ordinary publications issued by the Association during the year of their admission, and during the years in which they continue to pay, *without intermission*, their Annual Subscription.

(*c*) Associates are eligible to serve on the Reception Committee, but are not eligible to hold any other office, and they are not entitled to receive gratuitously the publications of the Association.

(*d*) Members may purchase from the Association (for the purpose of completing their sets) any of the Annual Reports of the Association, at a price to be fixed upon by the Council.

IV.—SUBSCRIPTIONS.

(*a*) Every Life Member shall pay, on admission as such, the sum of Ten Pounds.

(*b*) Ordinary Members shall pay, on election, [*an entrance fee of One Pound and*] an Annual Subscription of One Pound. Subsequent Annual Subscriptions shall be payable on the first day of July in each year.

(*c*) An Ordinary Member may at any time become a Life Member by one payment of Ten Pounds in lieu of future Annual Subscriptions.

(*d*) The Subscription for Associates for a Session shall be Fifteen Shillings.

V.—MEETINGS.

The Association shall meet in Session Annually. The place of meeting shall be appointed by the Council as far in advance as possible, and the arrangements for it shall be entrusted to the Local Committee, in conjunction with the Council.

VI.—COUNCIL.

(*a*) The Management of the affairs of the Association shall be entrusted to a Council, five to form a quorum.

(*b*) The Council shall consist of the President, Retiring President, four Vice-Presidents, two General Secretaries and a General Treasurer, together with one Member of Council for every twenty Members of the Association.

(*c*) The President, Vice-Presidents, General Secretaries and General Treasurer shall be nominated at a meeting of Council not later than two months previous to the Annual Session, and shall be elected at the Annual General Meeting.

(*d*) Ordinary Members of Council to represent centres having more than 20 Members shall, not later than one month prior to the Annual Session of the Association, be elected by each such Centre, in the proportion of one representative for every twenty Members. The Annual General Meeting shall elect other Ordinary Members of Council, in number so as to give, together with the Members of Council already elected by the Centres, in all, one Member of Council for every twenty Members of the Association.

(*e*) The Council shall have the power to co-opt Members, not exceeding five in number, from among the Members of the Association resident in that Centre at which the next ensuing Session is to be held.

(*f*) In the event of a vacancy occurring in the Council, or among the Officers of the Association, in the intervals between the Annual Sessions, or in the event of the Annual Meeting leaving vacancies, the Council shall have the power to fill such vacancies.

(*g*) During any Session of the Association the Council shall meet at least twice, and the Council shall meet at least six times during the year, in addition to such Meetings as may be necessary during the Annual Session of the Association.

(*h*) The Council shall have the power to pay for the services of Assistant General Secretaries, for such clerical assistance as it may consider necessary, and for such assistance as may be needed for the publication of the Association Report or Journal.

(*i*) The Council shall have power to frame Bye-laws to facilitate the practical working of the Association, so long as these Bye-laws are not at variance with the Constitution.

VII.—LOCAL AND RECEPTION COMMITTEES.

(*a*) A Local Committee shall be constituted for the Centre at which the Annual Session is to be held, and shall consist of the Members of the Council resident in that Centre, with such other Members of the Association as the said Members of Council may elect.

(*b*) The Local Committee shall form a Reception Committee to assist in making arrangements for the reception and entertainment of visitors. Such Reception Committee may include persons not necessarily Members or Associates of the Association.*

(*c*) The Local Committee shall be responsible for all expenses in connection with the Annual Session of the Association.

VIII.—HEADQUARTERS.

The Headquarters of the Association shall be in Cape Town.

IX.—FINANCE.

(*a*) The Financial Year shall end on the [*30th of June*] 31ST OF MAY.

(*b*) All sums received for Life Subscriptions and for Entrance Fees shall be invested in the names of three Trustees appointed by the Council, and only the interest arising from such investment shall be applied to the uses of the Association, except by resolution of a General Meeting.

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* The Reception Committee should make arrangements to provide :—

(1) A large hall for the delivery of the Presidential Address and evening lectures.

(2) A large room to be used as a Reception Room for members and others, at which all information regarding the Association can be obtained, and which shall have attached to it two Secretaries' Offices, a Writing Room for members and others, a Smoking Room, and Ladies' Room.

(3) Four rooms, each capable of accommodating about 30 or 40 people, to be used as Sectional Meeting Rooms, and, if possible, to have rooms attached, or in close proximity, for the purpose of holding meetings of Sectional Committees.

(4) Other requirements, such as office furniture, blackboards, window blinds to darken sectional meeting rooms for Lantern lectures, notice boards, etc.

(*c*) The Local Committee of the Centre in which the next ensuing Session is to be held shall have the power to expend money collected, or otherwise obtained in that Centre, other than the subscriptions of Members. Such disbursements shall be audited, and the financial statement and the surplus funds forwarded to the General Treasurer within one month after the Annual Session.

(*d*) All cheques shall be signed by the General Treasurer and a General Secretary, or by such other person or persons as may be authorised by the Council.

(*e*) Whenever the balance in the hands of the Treasurer 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.

(*f*) ON THE REQUEST OF THE MAJORITY OF THE MEMBERS OF COUNCIL OF ANY CENTRE IN WHICH TWO OR MORE MEMBERS OF COUNCIL RESIDE, THE COUNCIL SHALL EMPOWER THE LOCAL MEMBERS OF COUNCIL IN THAT CENTRE TO EXPEND SUMS NOT EXCEEDING IN THE AGGREGATE TEN PER CENTUM OF THE AMOUNT OF ANNUAL SUBSCRIPTIONS RAISED IN THAT CENTRE.

[(*f*)] (*g*) The whole of the accounts of the Association, *i.e.*, the local as well as the general accounts, shall be audited annually by an auditor appointed by the Council, and the balance-sheet shall be submitted to the Council at the first meeting thereafter, and be printed in the Annual Report of the Association.

X.—SECTIONS OF THE ASSOCIATION.

The Scientific Work of the Association shall be transacted under such sections as shall be constituted from time to time by the Council, and the constitution of such Sections shall be published in the Journal.

The Sections shall deal with the following Sciences and such others as the Council may add thereto from time to time:—Agriculture; Anthropology and Ethnology. Archæology; Architecture; Anatomy; Astronomy; Bacteriology; Botany; Chemistry; Education; Engineering; Eugenics; Geology and Surveying; Geography. Geology and Mineralogy; Irrigation; Mathematics; Mental Science; Meteorology; Philology; Physics; Physiology; Political Economy; Sanitary Science; Sociology; Statistics, Zoology.

XI.—RESEARCH COMMITTEES.

(*a*) Grants may be made by the Association to Committees or to individuals for the promotion of Scientific research.

(*b*) Every proposal for special research, or for a grant of money in aid of special research shall primarily be considered by the Sectional Committee dealing with the science specially concerned, and if such proposal be approved, shall be referred to the Council.

(*c*) A Sectional Committee may recommend to Council the appointment of a Research Committee, composed of Members of the Association, to conduct research or to administer a grant in aid of research.

(*d*) In recommending the appointment of Research Committees, the Sectional Committee shall specifically name all Members of such Committees; 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 shall be as small as is consistent with its efficient working.

(*e*) All recommendations adopted by Sectional Committees shall be forwarded without delay to the Council for consideration and decision.

(*f*) Research Committees shall be appointed for one year only, but if the work of a Research Committee cannot be completed in that year, application may be made, through a Sectional Committee, at the next Annual Session for re-appointment, with or without a grant—or a further grant—of money.

(*g*) Every Research Committee, and every individual, to whom a grant had been made, shall present to the following Annual 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.

(*h*) In each Research Committee, the Secretary thereof shall be the only person entitled to call on the Treasurer for such portions of the sums granted as may from time to time be required.

XII.—SPECIAL COMMITTEES.

The Council shall have power to appoint Special Committees to deal with such subjects as it may approve, to draft regulations for any such Committees, and to vote money to assist the Committees in their work.

XIII.—SECTIONAL COMMITTEES.

(*a*) The Sectional Committees shall consist of a President, two Vice-Presidents, two or more Secretaries, and such other persons as the Council may consider necessary, who shall be elected by the Council. Of the Secretaries, one shall act as Recorder of the Section, and at least one shall be resident in the Centre where the Annual Session is to be held.

(*b*) From the time of their election, which shall take place as soon as possible after the Session of the Association, they shall form themselves into 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.

(*c*) The Sectional Committees shall have power to add to their number from among the Members of the Association.

(*d*) The Committees of the several Sections shall determine the acceptance of Papers before the beginning of the Session, keeping the General Secretaries informed from time to time of their work. 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, and he should send it, together with the original Paper, to the Secretary of the Session before which it is to be read, so that it may reach him at least a fortnight before the Session.

(*e*) Members may communicate to the Sections the Papers of non-members.

(*f*) The Author of any Paper is at liberty to reserve his right of property therein.

(*g*) The Sectional Committees shall meet not later than the first day of the Session in the Rooms of their respective Sections, and prepare the programme for their Sections and forward the same to the General Secretaries for publication.

(*h*) The Council cannot guarantee the insertion of any Report, Paper or Abstract in the Annual Volume unless it be handed to the Secretary before the conclusion of the Session.

(*i*) The Sectional Committees shall report to the Council what Reports, Papers or Abstracts it is thought advisable to print, but the final decision shall rest with the Council.

XIV.—ALTERATION TO RULES.

Any proposed alteration of the Rules—

a. Shall be intimated to the Council three months before the next Session of the Association.

b. Shall be duly considered by the Council and communicated by Circular to the Members of the Association for their consideration, and dealt with at the said Session of the Association.

During the interval between two Annual Sessions of the Association, any alterations proposed to be made in the Rules shall be valid if agreed to by two-thirds of the Members of Council. Such alteration of Rules shall not be permanently incorporated in the Constitution until approved by the next Annual Meeting.

XV.—VOTING.

In voting for Members of Council, or on questions connected with Alterations to Rules, absent Members may record their vote in writing.

RULES FOR THE AWARD OF MEDALS.

A. The South Africa Medal.

I.—Constitution of Committee.

(*a*) The Council of the South African Association for the Advancement of Science shall, annually and within three months after the close of the Annual Session, elect a Committee to be called "the South Africa Medal Committee" on which, as far as possible, every Section of the Association and each Province of South Africa shall have fair representation.

(*b*) This Committee shall consist of eight Members elected from amongst Council Members, together with four other Members, selected from amongst Members of the Association who are not on the Council.

(*c*) The Chairman of the Committee shall be appointed annually by the Council from amongst its Members.

(*d*) Any casual vacancy in the Committee shall be filled by the Council.

II.—Duties.

(*a*) The duties of the Committee shall be to administer the Income of the Fund and to award the Medal, raised in commemoration of the visit of the British Association to South Africa in 1905, in accordance with the resolution of its Council.

(*b*) This resolution reads as follows:—

(1) That, in accordance with the wishes of subscribers, the South Africa Medal Fund be invested in the names of the Trustees appointed by the South African Association for the Advancement of Science.

(2) That the Dies for the Medal be transferred to the Association, to which, in its corporate capacity, the administration of the Fund and the award of the Medal shall be, and is hereby, entrusted, under the conditions specified in the Report to the Medal Committee.

(*c*) The terms of conveyance are as follows:—

(1) That the Fund be devoted to the preparation of a Die for a Medal, to be struck in Bronze, $2\frac{1}{2}$ inches in diameter; and that the balance be invested and the annual income held in trust.

(2) That the Medal and income of the Fund be awarded by the South African Association for the Advancement of Science for achievement and promise in scientific research in South Africa.

(3) That, so far as circumstances admit, the award be made annually.

(*d*) The British Association has expressed a desire that the award shall be made only to those persons whose Scientific work is likely to be usefully continued by them in the future.

III.—Awards.

(*a*) Any individual engaged in Scientific research in South Africa shall be eligible to receive the award.

(*b*) The Medal and the available balance of one year's income from the Fund shall be awarded to one candidate only in each year (save in the case of joint research); to any candidate once only; and to no member of the Medal Committee.

(*c*) Nominations for the recipient of the award may be made by any member of the South African Association for the Advancement of Science, and shall be submitted to the Medal

Committee not later than six months after the close of the Annual Session.

(*d*) The Medal Committee shall recommend the recipient of the award to the Council, provided the recommendation is carried by the vote of at least a majority of three-fourths of its Members, voting verbally or by letter, and submitted to the Council at least one month prior to the Annual Session for confirmation.

(*e*) The award shall be made by the full Council of the South African Association for the Advancement of Science after considering the recommendations of the Medal Committee, provided it is carried by the vote of a majority of its Members, given in writing or verbally.

(*f*) The Council shall have the right to withhold the award in any year, and to devote the funds rendered available thereby, in a subsequent award or awards, provided the stipulation contained in the second term of conveyance of the British Association is adhered to.

(*g*) No alteration shall be made in these Rules except under the condition specified in Rule XIV. of the Association's Constitution, reading:—

Any proposed alteration of the Rules—

a. Shall be intimated to the Council three months before the next Session of the Association.

b. Shall be duly considered by the Council, and be communicated by circular to the Members of the Association for their consideration, and dealt with at the said Session of the Association.

(*h*) Should a Member of the Medal Committee accept nomination for the Award or be absent from South Africa at any time within four months before the commencement of the ensuing Annual Session, he will *ipso facto* forfeit his seat on the Committee.

B. The Goold-Adams Medals.

(*a*) The Medals shall be awarded on the joint results of the Matriculation and University Senior Certificate Examinations of the University of the Cape of Good Hope.

(*b*) One Medal shall be awarded to the student who has taken the highest place in each of the seven Science subjects; (1) Physics, (2) Chemistry, (3) Elementary Physical Science, (4) Botany, (5) Zoology, (6) Elementary Natural Science, and (7) Mathematics, as set forth in the University Matriculation Examination and the University Senior Certificate Examination.

(*c*) The standard of marks shall be not less than 65 per cent. of the maximum.

(*d*) The Medals shall be struck in bronze.

(*e*) The first awards shall be made on the results of the 1910 examinations.

Table showing the Places and Dates of Meeting of the South African Association, with Presidents, Vice-Presidents, and Local Secretaries, from its Foundation.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
Sir DAVID GILL, K.C.B., LL.D., F.R.S., F.R S.E. CAPE TOWN, April 27, 1903.	S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Sir Charles Metcalfe, Bart., M.I.C.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R S.E. Gardner F. Williams, M.A.	J. D. F. Gilchrist, M.A., D.Sc., Ph.D., F.L.S.
Sir CHARLES METCALFE, Bart., M.I.C.E. JOHANNESBURG, April 4, 1904.	J. Fletcher, A.M.I.C.E. S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. Gardner F. Williams, M.A.	T. Reunert, M.I.C.E., M.I.M.E.
THEODORE REUNERT, M.I.C.E., M.I.M.E. JOHANNESBURG, August 28, 1905.	J. Fletcher, A.M.I.C.E. S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E. Gardner F. Williams, M.A.	W. Cullen.
GARDNER F. WILLIAMS, M.A. KIMBERLEY, July 9, 1906.	J. Burtt-Davy, F.L.S., F.R.G.S. James Hyslop, D.S.O., M.B., C.M. S. J. Jennings, M.Amer.I.M.E., M.I.M.E. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E.	W. M. Wallace, A.R.C.S., A.M.I.C.E.
JAMES HYSLOP, D.S.O., M.B., C.M. DURBAN, July 16, 1907.	J. Burtt-Davy, F.L.S., F.R.G.S. S. J. Jennings, M.Amer.I.M.E., M.I.M.E., M.I.M.M. Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R S.E. Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S.	C. W. P. Douglas de Fenzi.

H.E. the Hon. Sir WALTER HELY-HUTCHINSON, G.C.M.G., LL.D. GRAHAMSTOWN, July 6, 1908.	Prof. J. C. Beattie, D.Sc., F.R.S.E. S. J. Jennings, M.Amer.I.M.E., M.I.M.E., M.I.M.M. Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S. Ernest Williams, A.M.I.C.E., M.I.M.M.	Prof. J. E. Duerden, M.Sc., Ph.D., A.R.C.S. W. Hammond Tooke.
H.E. Sir HAMILTON GOOLD-ADAMS, G.C.M.G., C.B. BLOEMFONTEIN, September 27, 1909.	J. Burtt-Davy, F.L.S., F.R.G.S. Hugh Gunn, M.A. R. Marloth, M.A., Ph.D. Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S.	Prof. G. Potts, M.Sc., Ph.D. A. Stead, B.Sc., F.C.S.
THOMAS MUIR, C.M.G., M.A., LL.D. F.R.S., F.R.S.E. CAPE TOWN, October 31, 1910.	W. Cullen Hugh Gunn, M.A. Prof. P. D. Hahn, M.A., Ph.D. I. M. P. Muirhead, F.S.S., F.R.S.E.	C. F. Juritz, M.A., D.Sc., F.I.C.
Professor PAUL DANIEL HAHN, M.A., Ph.D. BULAWAYO, July 3, 1911.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. C. W. Howard, B.A., F.E.S. A. J. C. Molyneux, F.G.S., F.R.G.S. A. Theiler, C.M.G.	G. N. Bromehead.
ARNOLD THEILER, C.M.G., D.Sc. PORT ELIZABETH, July 1, 1912.	Prof. L. Crawford, M.A., D.Sc., F.R.S.E. J. Moir, M.A., D.Sc., F.C.S. A. J. C. Molyneux, F.G.S., F.R.G.S. W. Arnott	E. G. Bryant, B.A., B.Sc.

Presidents and Secretaries of the Sections of the Association.

SECTION A.—ASTRONOMY, CHEMISTRY, MATHEMATICS, METEOROLOGY AND PHYSICS.

Date and Place.	Presidents.	Secretaries.
1903. Cape Town ..	Prof. P. D. Hahn, M.A., Ph.D.	Prof. L. Crawford.
1904. Johannesburg*	J. R. Williams, M.I.M.M., M.Amer.I.M.E.	W. Cullen, R. T. A. Innes.
1906. Kimberley ..	J. R. Sutton, M.A.	W. Gasson, A. H. J. Bourne.
1907. Natal†	E. N. Neville, F.R.S., F.R.A.S., F.C.S.	D. P. Reid, G. S. Bishop.
1908. Grahamstown	A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E.	D. Williams, G. S. Bishop.

ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE AND GEOGRAPHY.

1909. Bloemfontein	Prof. W. A. D. Rudge, M.A.	H. B. Austin, F. Masey.
1910. Cape Town ‡	Prof. J. C. Beattie, D.Sc., F.R.S.E.	A. H. Reid, F. Flowers.
1911. Bulawayo ..	Rev. E. Goetz, S.J., M.A., F.R.A.S.	A. H. Reid, Rev. S. S. Dornan.
1912. Port Elizabeth	H. J. Holder, M.I.E.E.	A. H. Reid.

SECTION B.—ANTHROPOLOGY, ETHNOLOGY, BACTERIOLOGY, BOTANY, GEOGRAPHY, GEOLOGY, MINERALOGY AND ZOOLOGY.

1903. Cape Town ..	R. Marloth, M.A., Ph.D.	Prof. A. Dendy.
1904. Johannesburg	G. S. Corstorphine, B.Sc., Ph.D., F.G.S.	Dr. W. C. C. Pakes, W. H. Jollyman.
1906. Kimberley ..	Thos. Quentrall, M.I.Mech.E., F.G.S.	C. E. Addams, H. Simpson.

CHEMISTRY, METALLURGY, MINERALOGY, ENGINEERING, MINING AND ARCHITECTURE.

1907. Natal	C. W. Methven, M.I.C.E., F.R.S.E., F.R.I.B.A.	R. G. Kirkby, W. Paton.
1908. Grahamstown	Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.	Prof. G. E. Cory, R. W. Newman, J. Muller.

CHEMISTRY, BACTERIOLOGY, GEOLOGY, BOTANY, MINERALOGY, ZOOLOGY, AGRICULTURE, FORESTRY, SANITARY SCIENCE.

1909. Bloemfontein	C. F. Juritz, M.A., D.Sc., F.I.C.	Dr. G. Potts, A. Stead.

* Metallurgy added in 1904.

† Geography and Geodesy transferred to Section A and Chemistry and Metallurgy to Section B, in 1907.

‡ Irrigation added in 1910 and Geography transferred to Section B.

CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY AND GEOGRAPHY.

Date and Place.	Presidents.	Secretaries.
1910. Cape Town ..	A. W. Rogers, M.A., Sc.D., F.G.S.	J. G. Rose, G. F. Ayers.
1911. Bulawayo ..	A. J. C. Molyneux, F.G.S., F.R.G.S.	J G. Rose, G. N. Blackshaw.
1912. Port Elizabeth	Prof. B. de St. J. van der Riet, M.A., Ph.D.	J. G. Rose, J. E. Devlin.

SECTION C.—AGRICULTURE, ARCHITECTURE, ENGINEERING, GEODESY, SURVEYING, AND SANITARY SCIENCE.

Date and Place.	Presidents.	Secretaries.
1903. Cape Town ..	Sir Chas. Metcalfe, Bart., M.I.C.E..	A. H. Reid.
1904. Johannesburg *	Lieut.-Colonel Sir Percy Girouard, K.C.M.G., D.S.O.	G. S. Burt Andrews, E. J. Laschinger.
1906. Kimberley ..	S. J. Jennings, C.E., M.Amer.I.M.E., M.I.M.E.	D. W. Greatbatch, W. Newdigate.

BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE AND FORESTRY, PHYSIOLOGY, HYGIENE.

Date and Place.	Presidents.	Secretaries.
1907. Natal	Lieut.-Colonel H. Watkins Pitchford, F.R.C.V.S.	W. A. Squire, A. M. Neilson, Dr. J. E. Duerden.
1908. Grahamstown	Prof. S. Schonland, M.A., Ph.D., F.L.S., C.M.Z.S.	Dr. J. Bruce Bays, W. Robertson, C. W. Mally, Dr. L. H. Gough.
1910. Cape Town †	Prof. H. H. W. Pearson, M.A., Sc.D., F.L.S.	W. D. Severn, Dr. J W. B. Gunning.
1911. Bulawayo ..	F. Eyles, F.L.S., M.L.C.	W. T. Saxton, H. G. Mundy.
1912. Port Elizabeth	F. W. FitzSimons, F.Z.S., F.R.M.S.	W. T. Saxton, J. L. Drège.

SECTION D.—ARCHAEOLOGY, EDUCATION, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY AND STATISTICS.

Date and Place.	Presidents.	Secretaries.
1903. Cape Town ..	Thos. Muir, C.M.G., M.A., LL.D., F.R.S., F.R.S.E.	Prof. H. E. S. Fremantle.
1904. Johannesburg	(Sir Percy Fitzpatrick, M.L.A.), E. B. Sargant, M.A. (Acting).	Howard Pim, J. Robinson.
1906. Kimberley ..	A. H. Watkins, M.D., M.R.C.S.	E. C. Lardner-Burke, E. W. Mowbray.

EDUCATION, PHILOLOGY, PSYCHOLOGY, HISTORY, ARCHAEOLOGY: ECONOMICS AND STATISTICS, SOCIOLOGY, ANTHROPOLOGY AND ETHNOLOGY.

Date and Place.	Presidents.	Secretaries.
1907. Natal	R. D. Clark, M.A.	R. A. Gowthorpe, A. S. Langley, E. A. Belcher.

EDUCATION, PHILOLOGY, PSYCHOLOGY, HISTORY AND ARCHAEOLOGY.

Date and Place.	Presidents.	Secretaries.
1908. Grahamstown	E. G. Gane, M.A.	Prof. W. A. Macfadyen, W. D. Neilson.

* Forestry added in 1904.
† Sanitary Science added in 1910.

Date and Place.	Presidents.	Secretaries.

ECONOMICS AND STATISTICS, SOCIOLOGY, ANTHROPOLOGY AND ETHNOLOGY.

Date and Place.	Presidents.	Secretaries.
1908. Grahamstown	W. Hammond Tooke.	Prof. A. S. Kidd

ANTHROPOLOGY, ETHNOLOGY, EDUCATION, HISTORY, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY AND STATISTICS.

Date and Place.	Presidents.	Secretaries.
1909. Bloemfontein	Hugh Gunn, M.A.	G. C. Grant, Rev. W. A. Norton.
1910. Cape Town ..	Rev. W. Flint, D.D.	G. B. Kipps, W. E. C. Clarke.
1911. Bulawayo ..	G. Duthie, M.A., F.R.S.E.	G. B. Kipps, W. J. Shepherd.
1912. Port Elizabeth	W. A. Way, M.A.	G. B. Kipps, E. G. Bryant.

EVENING DISCOURSES.

Date and Place.	Lecturer.	Subject of Discourse.
1903. Cape Town ..	Prof. W. S. Logeman, L.H.C., B.A.	The Ruins of Persepolis and how the Inscriptions were read.
1904. Johannesburg	H. S. Hele-Shaw, LL.D., F.R.S., M.I.C.E.	Road Locomotion — Present and Future.
1906. Kimberley ..	Prof. R. A. Lehfeldt, B.A., D.Sc.	The Electrical Aspect of Chemistry.
	W. C. C. Pakes, L.R.C.P., M.R.C.S., D.P.H., F.I.C.	The Immunisation against Disease of Micro-organic Origin.
1907. Maritzburg ..	R. T. A. Innes, F.R.A.S., F.R.S.E.	Some Recent Problems in Astronomy.
Durban	Prof. R. B. Young, M.A., B.Sc., F.R.S.E., F.G.S.	The Heroic Age of South African Geology.
1908. Grahamstown	Prof. G. E. Cory, M.A.	The History of the Eastern Province.
	A Theiler, C.M.G.	Tropical and Sub-tropical Diseases of South Africa: their Causes and Propagation.
1909. Bloemfontein	C. F. Juritz, M.A., D.Sc., F.I.C.	Celestial Chemistry.
	W. Cullen.	Explosives: their Manufacture and Use.
Maseru	R. T. A. Innes, F.R.A.S., F.R.S.E.	Astronomy.
1910. Cape Town ..	Prof. H. Bohle, M.I.E.E.	The Conquest of the Air.
1911. Bulawayo ..	J. Brown, M.D., C.M., F.R.C.S., L.R.C.S.E.	Electoral Reform — Proportional Representation.
	W. H. Logeman, M.A.	The Gyroscope.
1912. Port Elizabeth	A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E.	Imperial Astronomy.
	Prof. E. J. Goddard, B.A., D.Sc.	Antarctica.

GENERAL MEETINGS AT PORT ELIZABETH.

On *Monday, July* 1, at 8 p.m., the Association was officially welcomed by His Worship the Mayor of Port Elizabeth (Mr. A. W. Guthrie, J.P.) at a reception held in the Town Hall.

On *Tuesday, July* 2, at 10 a.m., in the Stevenson Hall of the Collegiate School, Dr. A. Theiler, C.M.G., D.Sc., took the chair as President, and delivered an address, for which see page 1. A vote of thanks was accorded to the President by acclamation, on the motion of Mr. W. Cullen.

The President then presented the South Africa medal and grant to Dr. A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E. For the proceedings see page xxxiii.

At 8 p.m., in the Town Hall, Dr. A. W. Roberts delivered a discourse on "Imperial Astronomy," Mr. W. A. Way, M.A., presiding.

On *Wednesday, July* 3, at 11.30 a.m., the Tenth Annual General Meeting was held in the Stevenson Hall, Collegiate School for minutes of which see page xviii.

At 8 p.m., in the Town Hall, Prof. E. J. Goddard, B.A., D.Sc., delivered a discourse on "Antarctica," the Ven. Archdeacon A. T. Wirgman presiding.

On *Thursday, July* 4, at 8.30 a.m., Members of the Association proceeded on an excursion to the Zwartkops Saltpan and the Volcanic fissure at Mimosa.

On *Friday, July* 5, at 2.15 p.m., Members proceeded on an excursion to the Zwartkops thermal mineral spring and Baths, under the conductorship of Mr. G. W. Smith, A.M.I.C.E.

OFFICERS OF LOCAL AND SECTIONAL COMMITTEES, PORT ELIZABETH, 1912.

LOCAL COMMITTEE.

Chairman, W. Arnott; *Local Secretary*, E. G. Bryant, B.A., B.Sc.; J. C. H. Brincker, Rev. F. W. Flack, M.A., B.D., Prof. E. H. L. Schwarz, A.R.C.S., F.G.S., W. A. Way, M.A.

RECEPTION COMMITTEE.

Chairman, His Worship the Mayor of Port Elizabeth (A. Guthrie, Esq.); *Vice-Chairman*, Ven. Archdeacon Wirgman, D.D.; *Hon. Secretary*, E. G. Bryant, B.A., B.Sc.; *Hon. Treasurer*, W. F. Savage; W. Armstrong, Dr. J. Brock, J. Butters, A. S. Butterworth, A.M.I.C.E., J. H. Brown, O. Bracht, D. M. Brown, M.L.A., F. W. Cooper, J. A. Chabaud, A. Cowie, R. W. Craig, J. Daverin, W. Ramsay-Denny, I. L. Drège, A. Fettes, M.P.C., F. W. Fitzsimons, F.Z.S., M. Gilbert, H. J. Holder, A.M.I.E.E., W. Howe, F. Holland, H. A. Hirsch, F. Jones, C. F. Kayser, A. Linton, M. M. Loubser, D. Lumsden, W. Macintosh, C. H. Mackay, Rev. J. MacRobert, M.A., Dr. G. P. Mathew, H. Mosenthal, J. W. McWilliams, O. Middleton, A.R.I.B.A., Rev. J. Phillips, W. Pringle, E. Price, Rev. T. Richards, W. C. Scully, C.C. and R.M., E. Searle, W. S. Sholl, J. Fox Smith, G. W. Smith, A.M.I.C.E., J. Searle, M.L.A., H. S. Walpole, Hon. Sir E. H. Walton, K.C.M.G., M.L.A., J. A. Willet, G. S. Whitehead, D. M. Whyte, J. Wynne, M.P.C.

SECTIONAL COMMITTEES.

SECTION A.—ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE AND IRRIGATION.

President, H. J. Holder, M.I.E.E.; *Vice-Presidents*, Prof. L. Crawford, M.A., D.Sc., F.R.S.E., and Prof. A. Ogg, M.A., B.Sc., Ph.D.; Prof. J. C. Beattie, D.Sc., F.R.S.E., Rev. E. Goetz, M.A., F.R.A.S., J. Lyle, M.A., A. W. Roberts, D.Sc., F.R.S.E., Prof. W. A. D. Rudge, M.A.; *Hon. Secretary*, Arthur H. Reid, F.R.I.B.A. (*Recorder*).

SECTION B.—CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY AND GEOGRAPHY.

President, Prof. B. de St. J. van der Riet, M.A., Ph.D.; *Vice-Presidents*, Prof. G. H. Stanley, A.R.S.M., M.I.M.M., F.I.C., and A. Stead, B.Sc., F.C.S.; Prof. P. D. Hahn, M.A., Ph.D., C. F. Juritz, M.A., D.Sc., F.I.C., A. J. C. Molyneux, F.G.S., F.R.G.S., A. W. Rogers, M.A., Sc.D., F.G.S., Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.; *Hon. Secretaries*, J. G. Rose, F.C.S. (*Recorder*); J. E. Devlin, F.C.S., A.I.E.E.

Section C.—BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE, FORESTRY, PHYSIOLOGY, HYGIENE AND SANITARY SCIENCE.

President, F. W. FitzSimons, F.Z.S.; *Vice-Presidents,* Prof. S. Schönland, M.A., Ph.D., F.L.S., C.M.Z.S., and J. S. Henkel; E. W. Dwyer, B.A., Prof. R. Marloth, M.A., Ph.D., Prof. H. H. W. Pearson, M.A., Sc.D., F.L.S., L. Péringuey, D.Sc., F.E.S., F.Z.S., Prof. G. Potts, B.Sc., Ph.D.; *Hon. Secretaries,* W. T. Saxton, M.A., F.L.S. (*Recorder*), I. L. Drège.

Section D.—ANTHROPOLOGY, ETHNOLOGY, EDUCATION, HISTORY, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY AND STATISTICS.

President, W. A. Way, M.A.; *Vice-Presidents,* W. E. C. Clarke, M.A., and Prof. L. Fouché, B.A., Ph. et Litt.D.; Rev. W. Flint, D.D., E. G. Gane, M.A., W. Hammond Tooke; *Hon. Secretaries,* G. B. Kipps, F.R.G.S., (*Recorder*); E. G. Bryant, B.A., B.Sc.

PROCEEDINGS OF THE TENTH ANNUAL MEETING OF MEMBERS.

(Held in the Collegiate School, Port Elizabeth, on Wednesday, July 3, 1912.)

Present: Dr. A. Theiler, C.M.G. (President), in the chair; Mr. J. C. H. Brincker, Prof. Crawford, Mr. W. Cullen, Mr. J. E. Devlin, Mr. F. W. FitzSimons, Mr. J. A. Foote, Prof. R. A. Lehfeldt, Prof. W. A. Macfadyen, Prof. D. F. du Toit Malherbe, Rev. E. W. H. Musselwhite, Prof. A. Ogg, Prof. J. Orr, Dr. A. W. Roberts, Mr. T. Conyers Robson, Prof. Roseveare, Prof. E. H. L. Schwarz, Mr. J. D. Stevens, Prof. B. de St. J. van der Riet, Mr. A. Walsh, Mr. W. A. Way, Mr. J. A. Willet, and the Hon. General Secretaries (Mr. R. T. A. Innes and Dr. C. F. Juritz).

Minutes.—The Minutes of the Ninth Annual General Meeting, held on July 7, 1911, printed on pp. xvii to xix of the Report of the Bulawayo Session, were confirmed.

Annual Report of Council.—The Annual Report of the Council for 1911-12, having been suspended since Monday, July 1, was taken as read and adopted on the motion of Prof. Crawford, seconded by Prof. van der Riet (see pp. xxii.-xxiv.).

Report of Hon. Treasurer and Statements of Accounts for 1910-11.—The Treasurer's report and financial statement for 1910-11, which could not be submitted at the last Annual Meeting, were read and adopted on the motion of Mr. A. Walsh, seconded by Prof. Lehfeldt (see pp. xxiv.-xxvii.).

Report of Hon. Treasurer and Statements of Accounts for 1911-12.—The Treasurer's report and financial statements for 1911-12, having beeen suspended since Monday, July 1, were taken as read.

On the motion of Prof. Schwarz, seconded by Mr. Cullen, who expressed the view that it should be an instruction to the incoming Council to use every endeavour to collect all subscriptions due, the report and financial statements were adopted. (see pp. xxviii.-xxxii).

Revision of Constitution.—Mr. Innes submitted the report of a sub-committee of Council, consisting of Prof. Crawford, Mr. Foote, Mr. Innes, and Prof. Schwarz, appointed by Council to report to this meeting on the possibility of rendering the Association's Constitution more flexible in certain respects, the report recommending the following alterations in the Constitution:—

"Section IV. Subscriptions.

Delete 'an entrance fee of One Pound and.'

SECTION IX. FINANCE.

(*a*) Delete '30th of June' for the purpose of inserting '31st of May.'

Insert the following as a new sub-section:—

'(*f*) On the request of the majority of the Members of Council of any centre in which two or more Members of Council reside, the Council shall empower the local Members of Council in that centre to expend sums not exceeding in the aggregate ten per centum of the amount of annual subscriptions raised in that centre.'

The present sub-section (*f*) to be designated '(*g*).'

SECTION XIV. ALTERATION TO RULES.

Delete the whole Section for the purpose of substituting the following:—

> 'Any proposed alteration of the Rules shall be valid if agreed to by two-thirds of the Members of Council. Such alteration of Rules shall not be permanently incorporated in the Constitution until approved by the next Annual Meeting.'

SECTION XV. VOTING.

Delete 'or on questions connected with alterations to rules.'"

Mr. Innes, in moving the adoption of the report, said that Members of Council residing in the centre which had the largest numerical membership in the Association had their hands tied by the inelasticity of the Constitution, and, although they wished the headquarters of the Association to remain at the coast, it was their desire to obtain a greater local autonomy for themselves. He suggested that the incoming Council should be asked to act along the lines of the amendments recommended by the Committee, and that the next Annual Meeting should formally pass those amendments and indemnify the Council in the event of interim transgression of the letter of the present Constitution.

Mr. J. D. Stevens seconded.

Prof. Crawford suggested that the Meeting should discuss the *principles* involved in the proposed amendments before considering the time of their taking effect. This course was unanimously agreed to. It was also agreed that the sections and sub-sections of the report be considered *seriatim*.

The Meeting then proceeded to consider the adoption of the principles involved in each amendment.

The amendments to Sections IV and IX were approved of.

On the amendment to Section XIV, Prof. Lehfeldt moved that it is desirable that the present section should be retained, and the following added thereto as a new sub-section:—

> "During the interval between two Annual Sessions of the Association any alterations proposed to be made in the Rules shall be valid if agreed to by two-thirds of the

Members of Council. Such alteration of Rules shall not be permanently incorporated in the Constitution until approved by the next Annual Meeting."

Prof. Ogg seconded. Principle approved.

The amendment to Section XV was withdrawn.

On the Meeting proceeding to discuss the means for giving effect to these proposed amendments,

Dr. Macfadyen moved that the resolutions arrived at be conveyed to all members by circular, in order to afford them an opportunity of objecting to them, if so inclined, within one month, and that, failing any such objection, the Council should then be empowered to take the responsibility of acting upon these resolutions.

Mr. Cullen seconded. Carried.

Bloemfontein Philosophical Society.—The subject of the proposed affiliation of the Bloemfontein Philosophical Society, which had been held over by Council to be dealt with by the Annual General Meeting, in consideration of the fact that the Association's Constitution made no provisions for such cases, was referred to the incoming Council for disposal under the projected amendments to the Constitution.

Headquarters of the Association.—In view of the increased flexibility afforded by the amendments to the Constitution, the motion "That the time has arrived when the headquarters of the Association should be transferred to Johannesburg," whereof three months' notice had been given in accordance with the Rules, was withdrawn.

Election of Officers and Council for 1912-13.—The following officers were elected for 1912-13:—

President, Dr. A. W. Roberts, F.R.A.S., F.R.S.E.; Vice-Presidents, Prof. L. Crawford, M.A., D.Sc., F.R.S.E., and Mr. A. J. C. Molyneux, F.G.S., F.R.G.S.; General Secretaries, Mr. R. T. A. Innes, F.R.A.S., F.R.S.E., and Dr. C. F. Juritz, M.A., F.I.C.; General Treasurer, Mr. A. Walsh. (The retiring President, Dr. A. Theiler, C.M.G., is a member of Council, *ex-officio*.)

The election of two additional Vice-Presidents was referred to the incoming Council for disposal.

The following were elected as Members of Council for 1912-13:—

I. Transvaal.—*Witwatersrand*: Mr. P. Cazalet, Mr. E. A. E. Collins, Mr. W. Cullen, Mr. S. Evans, Mr. J. A. Foote, F.G.S., F.E.I.S., Prof. R. A. Lehfeldt, B.A., D.Sc., Dr. J. Moir, M.A., F.C.S., Prof. J. Orr, B.Sc., M.I.C.E., and Prof. G. H. Stanley, A.R.S.M., M.I.M.E., F.I.C. *Pretoria*: Mr. J. Burtt-Davy, F.L.S., F.R.G.S., Mr. W. E. C. Clarke, M.A., and Mr. F. E. Kanthack, A.M.I.C.E. *Potchefstroom*: Mr. A. Holm.

II. Cape Province.—*Cape Peninsula*: Dr. A. J. Anderson. M.A., M.B., D.P.H., M.R.C.S., Prof. J. C. Beattie, D.Sc., F.R.S.E., Rev. W. Flint, D.D., Prof. R. Marloth, M.A., Ph.D., Prof. H. H. W. Pearson, M.A., Sc.D., F.L.S., and Mr. A. H. Reid, F.R.I.B.A., F.R.San.I. *Grahamstown*: Mr. J. Hewitt, B.A. *Kimberley*: Dr. A. H. Watkins, M.D., M.R.C.S., M.L.A. *Port Elizabeth*: Mr. W. A. Way, M.A. *Stellenbosch*: Prof. B. de St. J. van der Riet, M.A., Ph.D.

III. Orange Free State.—(Referred to Council for disposal.)

IV. Natal.—*Durban*: Dr. A. H. McKenzie, C.M., M.R.C.S.

V. Rhodesia.—*Bulawayo*: Rev. S. S. Dornan, M.A., F.G.S. *Salisbury*: Mr. G. N. Blackshaw, B.Sc., F.C.S.

VI. Basutoland.—Rev. E. Jacottet.

VII. Mozambique.—(Referred to Council for disposal.)

The election of members to represent Queenstown, King William's Town, and Maritzburg was referred to Council.

Annual Session in 1913.—The President announced that the Council had agreed to accept an invitation to hold the next Annual General Meeting in Lourenço Marques.

Votes of Thanks.—Mr. W. Cullen moved, and it was carried by acclamation, that the thanks of the Association be accorded to the following:—

> To His Worship the Mayor and Mayoress of Port Elizabeth and the Members of the Reception Committee; to Miss Andrews and the Collegiate School Committee, for the use of the Collegiate School; to the Public Library Committee, for the use of the Library and the Subscribers' Reading Room; to the Members of the Local Committee; to the Port Elizabeth Club, the St. George's Club, and the Deutsche Liedertafel; to the Port Elizabeth Golf Club, the Port Elizabeth Tennis Club, and the Port Elizabeth Bowling Club; to the Zwartkops Saltpan Co., the Algoa Mining Co., and all others who have given hospitality in so many forms to the visitors; to the various South African Railway Administrations and to the Union Castle Mail Steamship Co., for facilities granted; to the Port Elizabeth Motor Club; and to the Press of Port Elizabeth for publicity given to the Association's proceedings.

A vote of thanks was also passed, on the motion of Mr. Cullen, to the retiring President, Dr. A. Theiler, to the local Secretary, Mr. E. G. Bryant, for the excellent manner in which the preparations for the Session and the various excursions had been organised, and to the General Secretary, Dr. C. F. Juritz, for his services during the continuance of the Session.

REPORT OF THE COUNCIL FOR THE YEAR ENDED 30TH JUNE, 1912.

1. No change having been made in the date on which the Association's year begins, the difficulty referred to in the opening paragraph of the last Annual Report continues. It is the expressed wish of members that this Report should be placed before them at the very commencement of the Association's Annual Session, but this is obviously inconvenient when the Session begins on the day after the close of the financial year. Any report covering the latter period must, previous to submission to members, receive the approval of Council, and the Association's books must accordingly be closed, under the circumstances above mentioned, some weeks before the termination of the Association's year. It is therefore suggested that the Association's financial year should close on the 31st of May instead of on the 30th of June.

2. MEMBERSHIP.—The number of members on the Association's records is somewhat smaller than it was twelve months ago. The following table shows the nett changes that have taken place in this respect; it comprises the membership as it now stands compared with that of last year:—

	1911.	1912.
Transvaal	276	263
Cape Province	253	230
Orange Free State	53	43
Natal	36	31
Rhodesia	34	38
Basutoland	12	11
Mozambique	7	8
Swaziland	1	1
German South-West Africa	1	1
Resident Abroad	27	24
Residence unknown	19	23
Total	719	673

The names of 71 members have been removed from the list in the intervening year, owing to death, resignation or failure to pay subscriptions. On the other hand, 32 new members have joined the Association. The number of life members on the roll is now 31, two life members, Messrs. A. H. Hartley and H. F. Strange, having died since last report.

3. REPORT OF CAPE TOWN MEETING, 1910.—The seventh Annual Volume of the Association's proceedings has been completed and bound. It comprises 481 pages, and is therefore intermediate in size between volumes 5 and 6.

4. Report of Bulawayo Meeting, 1911.—This volume is almost complete. Only one of the twelve monthly parts remains to be issued. Upon binding the volume will be slightly larger than the fifth volume. It will probably contain 36 papers printed *in extenso*. In the report of the Cape Town Meeting the papers printed in full numbered 53, and in the Bloemfontein Report of 1909 there were as many as 64. The 1908 Report contained only 45 papers *in extenso*, and the 1907 Report only 24. While the number of papers thus printed has diminished during the last three years, their average length has increased.

5. South Africa Medal and Grant.—On the recommendation of the South Africa Medal Committee, comprising Prof. J. C. Beattie, D.Sc., F.R.S.E. (Chairman), Prof. L. Crawford, M.A., D.Sc., F.R.S.E., Prof. P. D. Hahn, M.A., Ph.D., Mr. A. L. Hall, B.A., F.G.S., Mr. S. S. Hough, M.A., F.R.S., Dr. C. F. Juritz, M.A., F.I.C., Dr. T. Muir, M.A., F.R.S., Dr. L. Péringuey, F.E.S., F.Z.S., Dr. S. Schönland, M.A., F.L.S., C.M.Z.S., Prof. G. H. Stanley, A.R.S.M., F.I.C., Dr. A. Theiler, C.M.G., and Prof. E. Warren, D.Sc., the fifth award of the South Africa Medal, together with a grant of £50, has been made to Dr. A. W. Roberts, F.R.A.S., F.R.S.E., of Lovedale, Cape Province, in recognition of his astronomical researches.

6. Lectures.—The South African Lectures, which were not held during 1911, have not yet been resumed.

7. Grants for Research.—Your Council has co-operated with the Council of the Royal Society of South Africa in organising a General Research Grant Committee, under the auspices of which such funds as may in the future be devoted to the furtherance of scientific research will be administered by the Council of the Royal Society. Active steps have already been taken by the General Committee on which your Council had appointed four of the Association's members as its representatives, *viz.*: Prof. Gilchrist, Prof. Hahn, Dr. Juritz, and Mr. Reid.

8. Goold-Adams Medals.—The second series of awards was made in connection with the Senior Certificate and Matriculation Examinations held towards the close of last calendar year by the University of the Cape of Good Hope. The following were the successful candidates.

Mathematics: William Hofmeyr Craib, Gill College High School, Somerset East.

Chemistry: Albert St. Clair Caporn, South African College High School, Cape Town.

Elementary Physical Science: Richard Lester Coltman, King Edward VII School, Johannesburg.

Botany: Christina Minet Leppan, Eunice High School, Bloemfontein.

Physics: Victor Rau, Gymnasium High School, Lower Paarl.

9. Philadelphia Academy of Natural Sciences.—During the year under report the Association was invited to send a representative to the Centenary Anniversary of the Academy. At the request of your Council the Association was represented at the celebrations by Dr. Gardner F. Williams, one of its Past-Presidents.

10. The New Council.—On the basis of membership provided in the Association's Constitution the Council for the ensuing year should be thus distributed:—

Transvaal:	
Witwatersrand	9
Pretoria	3
Potchefstroom	1
Cape Province:	
Cape Peninsula	6
Grahamstown	1
Kimberley	1
King William's Town	1
Port Elizabeth	1
Queenstown	1
Stellenbosch	1
Orange Free State:	
Bloemfontein	2
Rhodesia:	
Bulawayo	1
Salisbury	1
Natal:	
Maritzburg	1
Durban	1
Basutoland	1
Mozambique	1

REPORT OF THE HONORARY TREASURER FOR THE YEAR ENDED 30TH JUNE, 1911.

I beg to submit the following report and accounts for the financial year ended June 30th, 1911.

On the 1st July, 1910, there were 693 members on the books, who owed £231 in the shape of arrears. Since then 69 new members have been elected, but only 42 of these have actually taken up their membership by payment of entrance fee and first annual subscription, while 43 have been struck off or resigned, which leaves the membership practically the same as it was at the commencement of the year.

Of the £231 outstanding on the 30th June, 1910, only £70 has been collected, and £399 has been paid in current subscriptions; this practically means that there are somewhere about 240 people who are still considerably in arrear with their subscriptions, and it is very evident that unless more interest can be developed amongst the members so as to induce them to pay their subscriptions more promptly, the future existence of the Society is very doubtful.

With regard to the actual expense of running the Association during the past year, two items, namely, the expense of the Annual Meeting and the Branch expenses, do not appear.

Salaries are somewhat lower, and the amounts paid out on account of the JOURNAL are also lower, but there are several accounts for printing the JOURNAL which were not paid prior to the close of the financial year.

Printing and stationery show an increase of about £10, and a new item of expenditure appears, namely, the rent of the Offices.

The Charges Account, including postage and sundries, is also somewhat higher.

The amount of subscriptions, exclusive of the Bloemfontein Meeting, collected in 1910 amount to £763, whereas in the year under review they only amount to £469 12s., a very considerable decrease in the available revenue.

Last year a considerable cash balance was shown in the Bank, but there were items of £300 borrowed from the fixed deposit, of entrance fees and life subscriptions account amounting to £95, which have been refunded to their proper accounts.

The Endowment Fund in the hands of the Trustees now stands at its proper amount of £1,091.

The South Africa Medal Funds stand at £1,401 17s. 10d., in addition to which there is a small amount of accrued interest which will appear in the current year's books.

I think it is very desirable that the names of all those people who are considerably in arrear with their subscriptions should be wiped off the list, as, so long as they remain, it is necessary for the Association to provide copies of the JOURNAL for them, and, although probably the reduction of the number would not make very much difference, it is highly necessary that every possible saving of expenditure should be carefully looked into, as, if the possible revenue is to be the basis of expenditure instead of the actual, it makes it very difficult to keep both sides of the account on the proper basis.

A. WALSH,
General Treasurer.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

REVENUE ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1911.

Expenditure.

	£ s. d.	£ s. d.
To Charges	£69 10 1	
,, Depreciation of Furniture	3 12 5	
,, Journal expenditure (less income)	231 9 0	
,, Rent of Offices	14 7 0	
,, Salaries	160 0 0	
,, Printing and Stationery	39 13 6	
		518 12 0
,, Balance to Balance Sheet		55 12 6
		£574 4 6

Income.

	£ s. d.	£ s. d.
By Subscriptions, 1910-1911	£399 12 0	
,, Arrears	70 0 0	
,, Cape Town Meeting surplus	6 3	
,, Interest on fixed deposit	23 14 7	
		493 12 10
,, Balance to Credit at 1st July, 1910		80 11 8
		£574 4 6

BALANCE SHEET AT 30TH JUNE, 1911.

Liabilities.			Assets.	
Subscriptions paid in advance, 1911-1912		£11 5 0	S.A. Medal Fund: In hands of Trustees	£1,401 17 10
Entrance Fees		42 0 0	Investments	1,091 0 0
Life Membership fees		30 0 0	Furniture	32 12 1
		83 5 0	Cash in Standard Bank to credit of current account	126 5 5
S.A. Medal Fund	1,401 17 10			
Endowment Fund	1,091 0 0			
Anthropological Committee	20 0 0			
		2,512 17 10		
Revenue Account				
Balance at Credit, 30th June, 1911		55 12 6		
		£2,651 15 4		£2,651 15 4

I certify that the foregoing statements have been prepared from the books of the Association, and that they correctly show its financial position on June 30th, 1911, as disclosed thereby.

J. M. P. Muirhead,
Honorary Auditor.

Cape Town, December 5th, 1911.

REPORT OF THE HONORARY TREASURER FOR THE YEAR ENDED 30TH JUNE, 1912.

In submitting the financial statement for the past year, I beg to report that the Revenue Account for the year, so far as the amount derived from subscriptions is concerned, shows a very considerable improvement, but the expenditure has been much more, owing to there having been a considerable amount paid out for accounts which really belong to the previous financial year. The amount actually received from subscriptions, both current and arrear, has been £598 15s., and had the whole of the members remitted their indebtedness, the balance on the credit side would have been a considerable one. Four hundred and thirty-six members and six Associates have paid the current year's subscription, and £158 has been received on account of arrears; this last item is unfortunately only a small amount of the total outstanding, as there is still £394 (subscriptions due to date) that has not been paid. As a considerable part of this amount is owing by members three and four years in arrear, I do not think that more than £150 of this can be considered recoverable.

The charges amount includes an amount of £13, the Secretary's expenses to Bulawayo.

The JOURNAL as at present issued is naturally the greatest expense, but the cost is small compared with the average amount spent on the old style of annual volume.

The printing and postage of the JOURNAL for the past eleven months has cost £232 14s. 3d., and £38 10s. 5d. has been received on account of sales, reprints and advertisements. This practically brings down the cost of the JOURNAL to just about £18 per month, so far as printing and postage are concerned.

With regard to the outstandings due by the Association, I have been unable to obtain the account for the June number of the JOURNAL, as it was printed very late in the month. With the exception of this account and the auditor's fee, nothing further is owing, and the amount to come in from advertisements and reprints will almost, if not quite, cover these expenses.

The Medal Fund, after the payment of this year's grant, stands at £1,416 6s. 5d., *i.e.*, £40 6s. 5d. more than the original amount.

The Endowment Fund stands at £1,198, which is all invested except the small amount that is due from the general account for a Life Member's subscription and three entrance fees (less a small amount of interest in the hands of the Trustees).

The future financial position of the Society depends very largely upon the regularity with which members pay up their annual subscriptions. With the present membership and regularly paid subscriptions, it should now be possible for the Society to carry out one of the principal objects for which it was founded, *viz.*, the payment of grants in aid of Scientific Research

I would like very much to draw the attention of the Council to the difficulty in submitting the accounts right up to the end of the financial year, on account of the meeting at which they have to be considered taking place on the first day of the following financial year.

I suggest that it is very desirable that some alteration should be made either in the date of the Annual Meeting, or the date at which the financial year ends.

A. Walsh,

General Treasurer.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

REVENUE ACCOUNT FOR PERIOD ENDING JUNE 21ST, 1912.

Expenditure.	£ s. d.	Income.	£ s. d.
To Charges	£31 2 7	By Subscriptions, 1911-1912	£440 0 0
,, Depreciation on Furniture	3 5 3	,, ,, arrears	158 0 0
,, Journal	388 4 0	,, ,, Associate	0 15 0
,, Rent of Office	30 0 0	,, Interest on Endowment Fund	38 14 0
,, Salaries	160 0 0	,, Balance to Credit, July 1, 1911	55 12 6
,, Printing and Stationery	31 16 1		
,, Stamps and Telegrams	30 1 4		
,, Balance to Balance Sheet	18 12 3		
	£693 1 6		£693 1 6

BALANCE SHEET.

Liabilities.	£ s. d.	Assets.	£ s. d.	£ s. d.
Subscriptions paid in advance	£15 0 0	Endowment Fund Invest.		£1,185 13 3
Endowment Fund	1,198 0 0	Medal Fund		1,416 6 5
Medal Fund	1,416 6 5	Furniture		29 6 10
Anthropological Committee	20 0 0	Cash at Standard Bank	£53 8 10	
Revenue Account balance	18 12 3	Less cheques not presented	16 16 8	
				36 12 2
	£2,667 18 8			£2,667 18 8

I hereby certify that I have examined the above Balance Sheet and Revenue Account with the Books, vouchers and Banker's Pass Book relating thereto, and that in my opinion they correctly set forth a true and correct statement of the affairs of the Association as shown by the books thereof.

HY. GIBSON,
Incorporated Accountant,
Certified Accountant (Cape).

Cape Town, 24th June, 1912.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

S.A. ENDOWMENT FUND.

REVENUE AND EXPENDITURE ACCOUNT.

Interest paid to Revenue account	£38 14 0	Balance, July 1st, 1911	£1,091 0 0
Balance	1,198 0 0	Entrance fees	67 0 0
		Life Members	40 0 0
		Interest	38 14 0
	£1,236 14 0		£1,236 14 0

BALANC E SHEET.

Liabilities.		Assets.		
Balance due June 30th, 1912.	£1,198 0 0	Standard Bank Deposit		£1,152 15 0
		P.O. Savings Bank		32 18 3
		Due from General Account	£13 0 0	
		Less interest not paid over	13 3	
				12 6 9
	£1,198 0 0			£1,198 0 0

I hereby certify that I have examined the above Balance Sheet and Revenue with the books, vouchers and Bankers' Pass Book relating thereto, and that in my opinion they correctly set forth a true and correct statement of the affairs of the above Fund, as shown by the books thereof.

Hy Gibson,
Incorporated Accountant,
Certified Accountant (Cape).

Cape Town, 24th June, 1912.

SOUTH AFRICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

S.A. MEDAL FUND.

REVENUE AND EXPENDITURE, YEAR ENDING JUNE 30TH, 1912.

EXPENDITURE.		REVENUE.	
Grant Péringuey	£50 0 0	Balance, July 1st, 1911	£1,401 17 10
" Roberts	50 0 0	Interest	114 16 4
Engraving Medals	7 9		
Balance	1,416 6 5		
	£1,516 14 2		£1,516 14 2

BALANCE SHEET.

LIABILITIES.		ASSETS.	
Accumulated Funds	£1,416 6 5	Government Stocks	£1,376 0 0
		P.O. Savings Bank Deposit	40 5 8
		In hands of Chairman of Trustees	0 0 9
	£1,416 6 5		£1,416 6 5

I hereby certify that I have examined the above Balance Sheet and Revenue Account with the Books, vouchers and Bankers' Pass Book relating thereto, and that in my opinion they correctly set forth a true and correct statement of the affairs of the above fund as shown by the books thereof.

HY. GIBSON,
Incorporated Accountant,
Certified Accountant (Cape).

Cape Town, 24th June, 1912.

The South Africa Medal.

FIFTH AWARD OF THE SOUTH AFRICA MEDAL AND GRANT.

(Fund raised by Members of the British Association in commemoration of their visit to South Africa in 1905.)

Dr. Alexander Roberts, F.R.A.S., F.R.S.E., was nominated for the award upon the following grounds:—

"For the past twenty years Dr. Roberts has devoted all the time which he was able to spare from his responsible duties at Lovedale, to the study of variable stars and kindred astronomical work.

"Beginning in 1891 with no other equipment than an old theodolite and an opera glass, he made a survey of the southern sky south of declination 30°, and, in spite of the slender resources at his disposal, was rewarded by the discovery of twenty variable stars in the course of the next two or three years.

"Notable as this result of statistical research in itself was in regard to our knowledge of the structure of the universe, it constituted for Dr. Roberts only the first stepping-stone towards a sphere of scientific work of a far more general and important character. Henceforth he devoted his energies to a detailed examination of the light curves of variable stars, a research rendered possible by the presentation of a new equatorial telescope especially designed for this class of work.

"He at once clearly recognised the importance of a detailed study of the so-called Algol variables from the standpoint of cosmical evolution.

"The light fluctuations of these variables are now known to be caused by eclipse phenomena recurring at regular intervals owing to the revolutions of two stars round a common centre of gravity, the plane of orbital motion being so situated that the light of one star is eclipsed in the direction of the line of sight by the other.

"Not only did he contribute more than any other observer of variable stars to the knowledge of facts, but he applied his great mathematical abilities to the consideration of the physical causes underlying these light phenomena, and developed a mathematical theory which enabled him to determine the density and figure of the two components and also their orbital motion.

"This unique combination of observational skill with a clear insight into the theoretical vistas of the problem has resulted in the production of over 100 important contributions to scientific journals, giving Dr. Roberts world-wide reputation as an astronomer. It would be impossible to enter fully upon the public appreciation of his scientific work, but I may be allowed to quote the following remarks by two of our leading scientists.

"In his presidential address to the British Association at

Cape Town in 1905 Sir George Darwin said, with reference to variable-star work:

"This is a branch of Astronomy to which much careful observation and skilful analysis has been devoted; and I am glad to mention that Alexander Roberts, one of the most eminent of the astronomers who have considered the nature of variable stars, is a resident in South Africa."

"In the Handbook 'Science in South Africa' Sir David Gill says:

"I know few instances of more successful devotion of small means and limited opportunity to the attainment of great scientific ends than the work of Dr. Roberts."

"These terms of high appreciation will show that no more suitable recipient can be found than Dr. Roberts for the award of the South Africa Medal, and it is with considerable pleasure that I urge upon the South African Association for the Advancement of Science the great claims which a scientist of his character and attainments has upon their consideration, especially as I feel confident that the result will be a further stimulus to his efforts, productive of valuable contributions to the astronomy of the future."

After the conclusion of the Presidential Address in the Stevenson Hall of the Collegiate School, Port Elizabeth, the President, Dr. A. Theiler, handed the South Africa medal and award of £50 to Dr. Roberts. In doing so the President said:

"Our medallist is one of the foremost astronomers of the world, and in every sense but one of the word he is an amateur; astronomy is a science to which he devotes his time when the daily duties of his office have been fulfilled. The sense of the word 'amateur' which I reserved is that sometimes the word suggests a sort of intermittency of work, or that its standard, although very good for a non-professional, is not of the highest class. This reservation does not apply to our medallist, who I fear has now and then deprived himself of the rest so necessary for complete health. In his special branch, the study of variable stars, he is indeed one of the *facile princeps*. His observations extend over twenty-one years, in which time he has made 75,000 observations which involved nearly 2,000,000 light-determinations with comparison stars, and all this with a meagre equipment of instruments that less talented men might have despised. This record alone would entitle Dr. Roberts to our consideration, but he has done far more. Besides the capacity and patience to make observations, he has had the capacity to reduce and the genius to interpret them. His special line to which he has kept with surprising but quite commendable fortitude, is that of the variable stars, but even in this branch he has been a specialist in the class of variable stars of the Algol type.

"The constancy of the light of our own star (the Sun), albeit it is supposed to vary some 1 or 2 per cent., and the constancy of the light of nearly all the stars visible to the naked eye, did not predispose the human mind to the idea of variable stars, and, in fact, none were known to the great astronomers of the early ages; in short, it was not until 1596 that Fabricius discovered the variable star since known as Mira Ceti, and nearly another two centuries elapsed (1782) before Algol was discovered to be variable. It is perhaps remarkable that these two variable stars are at the extremes of the varieties or species into which variables can be separated. The star Mira Ceti varies slowly from about the second magnitude to the eighth in a period of about 332 days—in other words, its brilliancy changes eight hundred-fold in less than a year, and life as we know it on our planet would be impossible if our Sun varied its emission in this ratio. In spite of numerous investigations, powerfully aided by spectroscopic means, the causes of such variations, and more especially of its periodicity, remain hidden. At the other end of the scale are the eclipsing or Algol variables. The diminution of light in these cases is short; thus Algol shines with an invariable light for two days thirteen and a half hours, at the end of which its light diminishes for three and a half hours; it remains dimmed for fifteen minutes, and in another three and a half hours it is again shining with its usual light. The obvious explanation that the temporary diminution is caused by an eclipsing body has been amply confirmed. With such a result one might have thought the matter was ended, but it is just here that the sagacity of our medallist came in. By means of his careful studies of the rates of diminution and regain of light, he was able to greatly extend our knowledge of Algol systems. Here I cannot do better than quote some of his words concerning the variable star V Puppis which appeared in the *Astrophysical Journal* of April, 1901:

" 'If, however, the two stars of this eclipse variable revolve in close contiguity there must be distortion to such an extent as to modify slightly the form of the light curve. But whatever be the amount of distortion, unless actual contact takes place, there will be a stationary period.

" 'On the other hand, if the stars are near enough for their mutual attractions to form a nexus between them, then there will be no stationary period, but the light curve at maximum will be rounded, the sharpness of the curve depending on the oblateness of the stars.

" 'A simple examination of the light curve of V Puppis indicates that there is no stationary period at either maximum and accordingly we must infer that the two component stars revolve around one another in actual contact.

" 'In this case there must be considerable distortion in the form of the two stars, especially at the point where the two bodies meet.

" 'It is not possible, although an attempt has been made, to determine the amount of this distortion; the conditions of the problem are too complex, the nature of the action of the forces to be considered too indefinite, and the data at our disposal too meagre to enable us to come to a satisfactory conclusion.'

"Pear-shaped rotating bodies and rotating fluid masses where the pear-shape is elongating to the point of fission have formed the subject of many mathematical investigations by such mathematicians as Poincare, G. H. Darwin, Jeans and others. It is pleasing to know that our medallist has proved the actual existence of such bodies in our universe.

"Dr. Roberts's first researches on the density of Algol-type stars appear in the *Astrophysical Journal* for December, 1899, but were written in April of that year; they were printed next to Mr. H. N. Russell's paper on the same subject, which was, however, only written in October. It thus appears that both authors nearly simultaneously and quite independently found out that it was possible, in the case of an Algol star, to deduce a limiting value for its mean density. Dr. Roberts's result for the four stars he considered showed that the average density of a close Algol variable is only 0.13 (say one-eighth) that of the Sun, and Mr. Russell summarizes by saying: 'Notwithstanding the causes of uncertainty, it is evident that the Algol variables as a class are much less dense than the Sun, probably less than one-fourth as dense.'

"These distinguished achievements make it unnecessary to do more than just to mention that Dr. Roberts is himself a discoverer of many variable stars, and that he has investigated the periods of southern variable stars and published the results in a well-known catalogue.

"Our medallist's assiduity and single-heartedness in his astronomical work would alone have entitled him to our consideration. We are grateful that, in addition to those good qualities, we have been able to recognise the spark of genius. Dr. Roberts, in the name of the Association, it gives me pleasure to present to you this our medal, and our best wishes for the successful continuation and fruition of your valuable work accompany it."

Dr. Roberts, in expressing his thanks, said that he felt it a great honour that the Association should single him out in this way. It was an extreme pleasure to him to be regarded as one of the astronomers of the country, and he was proud, as an amateur, to belong to that body. He would be glad if the honour which had come to him would be the means of inducing others to give up a portion of their time to the study of one or other of the sciences. He felt specially honoured in that this mark of the Association's appreciation had been presented to him by so distinguished a scientist as the President.

Previous Recipients.

1908. *Grahamstown.*—Arnold Theiler, C.M.G., M.D., Bacteriologist to the Transvaal Government, Pretoria.

1909. *Bloemfontein.*—Harry Bolus, D.Sc., F.L.S., of Sherwood, Kenilworth, Cape Division.

1910. *Cape Town.*—John Carruthers Beattie, D.Sc., F.R.S.E., Professor of Physics, South African College, Cape Town.

1911. *Bulawayo.*—Louis Péringuey, D.Sc., F.E.S., F.Z.S., Director of the South African Museum, Cape Town.

ASSOCIATION LIBRARY.

The following publications are regularly filed at the office of the Association, Cape of Good Hope Savings Bank Buildings, St. George's Street, Cape Town, and are available for perusal by members daily.

General Science.

Memoirs of the Royal Society of South Australia.
Transactions of the Royal Society of South Australia.
Proceedings of the Royal Society of Edinburgh.
Proceedings of the Royal Society of Victoria.
Proceedings of the Royal Institution of Great Britain.
Proceedings of the Royal Philosophical Society of Glasgow.
Journal of the Royal Society of Arts.
Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften.
Servian Royal Academy of Sciences: Comptes rendus.
Servian Royal Academy of Sciences: Year Book.
Michigan Academy of Sciences: Reports.
Atti della Reale Accademia dei Lincei, Rome.
Kungl. Svenska Vetenskapsakademiens Handlingar.
Kungl. Svenska Vetenskapsakademiens Årsbok.
Verhandelingen der Koninklijke Akademie van Wetenschappen, Amsterdam.
Koninklijke Akademie van Wetenschappen, Amsterdam: Proceedings of the Section of Sciences.
Revista de la Real Academia de Ciencias de Madrid.
Report of the British Association for the Advancement of Science.
Report of the Australasian Association for the Advancement of Science.
Atti della Società Italiàna per il progresso delle Scienze.
Transactions of the Cambridge Philosophical Society.
Proceedings of the Cambridge Philosophical Society.
Memoirs and Proceedings of the Manchester Literary and Philosophical Society.
Proceedings of the American Philosophical Society.
University of Virginia: Philosophical Society Bulletins.
Annals of the New York Academy of Sciences.
Proceedings of the American Academy of Arts and Sciences.
Proceedings of the California Academy of Sciences.
Transactions of the Academy of Science of St. Louis.
Proceedings of the Academy of Natural Sciences of Philadelphia.
Archives Néerlandaises des sciences exactes et naturelles.
Annaes scientificos da Academia polytechnica do Porto.
Proceedings of the Rhodesia Scientific Association.
Memoires de la Société de physique et d'histoire naturelle de Genève.

Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger.
Comptes rendus des séances de la Société de physique et d' histoire naturelle de Genève.
Sitzungsberichte der Gesellschaft naturforschender Freunde, Berlin.
Vierteljahrsschrift der naturforschenden Gesellschaft, Zurich.
Bulletin of the Imperial Institute.
Transactions and Proceedings of the New Zealand Institute.
Annual Report of the Smithsonian Institution.
Annual Report of the Smithsonian Institution (United States National Museum).
Annals of the Transvaal Museum.
Annals of the Natal Museum.
Field Museum of Natural History Publications.
University of Pennsylvania Museum Journal.
Bulletin of the Public Museum of Milwaukee.
Records of the Albany Museum.
Knowledge.

Chemistry, Metallurgy, and Geology.

Journal of the Chemical, Metallurgical, and Mining Society of South Africa.
Kungl. Svenska Vetenskapsakademien: Arkiv för Kemi, Mineralogi, och Geologi.
Transactions of the Geological Society of South Africa.
Geological Survey of New South Wales:
- Records.
- Memoirs.
- Mineral Resources.

Bulletins of the Geological Institution of Upsala.
Abstracts of Proceedings of the Geological Society, London.
Bulletins of the United States Geological Survey.
United States Geological Survey:
- Professional Papers.
- Annual Reports.

The Chemical News.

Meteorology.

Quarterly Journal of the Royal Meteorological Society.
Bulletins of the Mount Weather Observatory.

Agriculture.

Annali della Regia Scuola superiore agricoltura di Portici.
International Institute of Agriculture, Rome:
- Bulletin of Agricultural statistics.
- Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases.

Agricultural Journal of the Union of South Africa.
United States Department of Agriculture Experiment Station Record.

Biology and Physiology.

Bulletin de la Société Imperiale des naturalistes de Moscou.
Kungl. Svenska Vetenskapsakademien:
Arkiv för Botanik.
Arkiv för Zoologi.
Journal of the Linnean Society, Botany.
Bulletin of the Wisconsin Natural History Society.
Transvaal Medical Journal.
University of California: Publications in Botany.
Missouri Botanical Garden Annual Reports.
Smithsonian Institution (United States National Museum): Contributions from the United States National Herbarium.

Entomology.

Report of the South African Central Locust Bureau.
Zeitschrift für wissenschaftliche Insektenbiologie.

Astronomy, Mathematics and Physics.

Memoirs of the Royal Astronomical Society.
Monthly Notices of the Royal Astronomical Society.
Union Observatory Circulars.
Observatoire Royal de Belgique; annuaire astronomique.
Journal of the British Astronomical Association.
Memoirs of the British Astronomical Association.
Lick Observatory Bulletins.
Kungl. Svenska Vetenskapsakademien: Arkiv för Matematik, Astronomi och Fysik.
Proceedings of the London Mathematical Society.
Die Tätigkeit der physikalisch-technischen Reichsanstalt, Charlottenburg.
Report of the National Physical Laboratory, Middlesex.
National Physical Laboratory: Collected Researches.
Proceedings of the Physical Society of London.

Political Economy and Social Science.

United Empire.
International Institute of Agriculture, Rome: Bulletin of the Bureau of Economic and Social Intelligence.

Geography, Oceanography and Hydrography.

Società Italiana per il progresso delle Scienze: Bollettino del Comitato talassografico.

The Geographical Journal.
Bulletin of the American Geographical Society.
United States Geological Survey: Water Supply Papers.

Engineering.

Proceedings of the American Institute of Electrical Engineers.
Journal of the South African Institute of Engineers.
Transactions of the South African Institute of Electrical Engineers

Technology.

Patents for Inventions: Abridgments of Specifications.
The Illustrated Official Patents Journal.

PRESIDENT'S ADDRESS.

ADDRESS

BY

Dr. ARNOLD THEILER, C.M.G., D.Sc.,

PRESIDENT.

In the constitution of the South African Association for the Advancement of Science one of the desiderata put forth is "to obtain a more general attention to pure and applied science." When looking through the list of past Presidents, it occurred to me that either purposely or inadvertently that excellent idea had clearly been brought out by the nominations for the various meetings; the list embraces both men whose occupation was in the realm of pure science, as well as those who applied science to the contingencies of industry and commerce. To my mind this practice indicates the true spirit in which science has been regarded in the past by the founders of the Society, and it is desirable that the same spirit should prevail in the future. My best thanks are due to the Council for electing me as President for this meeting; it is an honour which I, as well as my profession, highly appreciate, and I regard it as an expression of the spirit alluded to. Hitherto my occupation in science has been, so to say, more of an economical nature. This fact and the selection of the town of Port Elizabeth as the meeting-place for 1912 seemed to indicate that my address should be connected with the economical side of science, particularly in reference to the application of biological principles to the branch in which I have been engaged—I might call it "Theory and Practice" in the investigation of Stock diseases of South Africa. Port Elizabeth is renowned for its best Agricultural Shows; for many years past it has held the record, and the people of this town mean to keep up their reputation in the future; it is also famous for its ostrich-feather market, and it commands the greatest wool exporting trade of South Africa. These facts are the connecting-links with the practical science of Agriculture. But Port Elizabeth also maintains a Museum practically unsupported by State assistance; for its upkeep it relies principally on the resources of this town, a fact which shows that the inhabitants of this town take also an interest in pure science.

Generally speaking, the South African is decidedly of a practical disposition, and the utility of any investigation is the first thing with which he is concerned. This can be well understood by those who come in close contact with the population, and who realise all the difficulties which an inhabitant of this sub-continent has to face in his struggle for existence.

Whilst I readily admit that in our investigations the economical side should always be considered first of all, yet, if we really want to ensure steady progress, we must not let the utilitarian point overshadow other considerations. When we begin a scientific investigation we never know where it will finally lead to. What appears to one man as useless will be turned to good account by another. Some people have no use for pure sciences, whilst to others it represents the whole object of their lives. Science is a result of advanced civilisation, and, in my opinion, it must be employed to serve mankind both for his intellectual and economical development. In South Africa the people who apply science to everyday requirements are called experts. I believe I am correct in saying that the expression was imported from America. One frequently hears the objection that their conclusions and recommendations are too theoretical, and as such are useless for the purpose of the practice, but this view can only be the result of a misunderstanding. When investigations have been made, and when a number of facts have been recorded, then they require to be interpreted, and to do this they are explained by connecting them with already established principles. For this purpose theories are necessary; they are the rays of light in the chaos of observations which at first sight frequently seem totally contradictory. There is hardly any theory which has not done something towards clearing up the obscurity of the problem, and I will show that in the investigation of diseases there are theories based on well-established points and formed by comparisons with other conditions which are capable of explaining observations and leading to practical issues. You are aware that the science in which I am particularly engaged deals with the investigation into the causes of stock diseases in South Africa, with the object of finding ways and means to combat them either through the medium of the State or of the farmer himself. This is a branch of applied biology, which during the last fifteen years has been so much in the foreground. It occupies the attention of practically every South African, since, in this sub-continent, stock-raising forms the main occupation of the majority of the population; it has forcibly been brought home through the invasion of the country by some of the most devastating plagues during the last two decades. It is therefore quite natural that I should select my examples amongst those subjects which are most familiar to me, or in which I have personally taken more than a casual interest. Let me tell you first of all that it is a mistake to think that South Africa alone is the country to which the picture of the ten plagues of Egypt applies; it is a calumny to say that there are more diseases in this sub-continent than anywhere else in the world; in fact, this country has not one specific disease of its own of any importance. From an epizoological point of view South Africa must only be considered to be a portion of the proverbial dark continent, and although considerable light has been thrown on many of the older diseases, there are still some in comparative darkness at the present time. The opening up of this continent, chiefly commencing from the South, brought the white man into touch with the existing diseases; owing to the geographical situation and ethnographical separation these maladies had hitherto been confined in patches, or, as a result of the survival of the fittest, they had created classes of animals immune against them. The advance of civilisation meant removal of such barriers, and the introduction of animals not immune to these diseases caused recrudescences. The true explanation is that the great majority of these maladies were not previously known to science, and it was only through research work in South Africa that the greater number of them were described. Since those days they have been found in other parts of Africa. For instance, horse-sickness is found all along the East Coast, in Central Africa, and along the shores of the Red Sea. Quite recently, through the kindness of the Bacteriologist of the Italian Colony of Erithrea, a sample of virus was sent to me with which I produced the horse-sickness that is so familiar to us all. Redwater is known throughout the whole continent. East Coast fever has been described in some of the countries bordering the Mediterranean. They were there all the time, and it was only since these diseases formed the subjects of thorough investigation in South Africa that attention was drawn to them in the countries so close to Europe. Although in this end of Africa much mystery and even a great amount of superstition was at one time connected with them a large amount of valuable observations had been collected by our farmers before any investigations had been made by experts. The farmers' interpretations led to certain conclusions which had become more or less common knowledge; they were carried down from generation to generation, and accepted as old-established truisms. In the light of modern knowledge many of these opinions no longer held good, and it appeared to many an old farmer almost a blasphemy to abandon the notions which had directed him in all his undertakings on his farm since the days of his childhood. There was a time, and perhaps still is, when the experts were looked upon with suspicion. I cannot help sympathising with this people, but I have no sympathy with those of whom one would expect that their education would enable them to understand logical and scientific reasoning. As I said, the observations were, in the majority of instances, correct, and I have no hesitation in saying that in most of my work, first of all I relied on the information given by the sons of the soil. I have done so up to the present time, and I shall not fail to do so again when opportunity occurs. It is true that much information is wrapped up with personal opinion, and even a layman requires his own theories to explain his observations, but a careful analysis usually helps to separate the two. My paper will also show that these so-called empiric notions have given valuable assistance to the unbiassed scientific worker.

Now let us look into the diseases of South Africa, which everyone at one time thought to be typical of this sub-continent. To begin with, I will mention the "tsetse fly" disease. This may perhaps not be the oldest known, but it is a classical one, and was already mentioned in the writings of the great Livingstone. This one has been well studied, and at the present time it still forms the basis of many theoretical speculations of a far-reaching nature. The name of a distinguished scientist well known in South Africa, Sir David Bruce, is connected with it. Bruce started his work in Zululand, in 1895, through the protection of a man much devoted to science, the then Governor, Sir Walter Hely Hutchinson; his name will always be remembered as a past President of our Association, and as a friend of every man engaged in scientific investigations and research. In the blood of an infected animal suffering from a disease which the Zulus called *Nagana*, Bruce found a micro-organism not previously seen in any part of Africa, a parasite belonging to the group of trypanosomes, and now named after its discoverer. The credit is due to Bruce not so much for finding this parasite, which in our days seems but a trivial thing, but for showing the connection between these parasites, the game of the country in which they were living, and from which they were transmitted to healthy stock by means of the tsetse fly, and in understanding from the very beginning its true meaning and importance. This led to the conception of the "reservoir of the virus," meaning that the germs of a disease are present in some animals where they live in a state of symbiosis, not causing any disease, and from which they are obtained by the blood-sucking insects and transmitted to the susceptible animal. The notion of the old hunters of the country that the fly was almost constantly associated with the buffalo did not explain the mystery of the home of the disease, although it was known at that time that the bite of the flies was succeeded by *nagana*; Bruce explained it, howevr, by the discovery of the parasite. This fact, once established, formed the clue for understanding many other diseases of a similar nature, and in particular it fostered the study of human malaria. Once it had been realised that in this disease the blood parasite was a protozoon, the investigations received a great impetus by the new views of *nagana* and its connection with the tsetse fly. The knowledge gained from the observations in Zululand had still a more far-reaching effect. It was the key to other investigations which led to one of the most brilliant discoveries of recent times, to the discovery of the cause of sleeping sickness. The history, as related to me by Bruce, is particularly interesting, and it shows how quickly results may be obtained when theoretical deductions are thoroughly grasped and understood. The Royal Society sent Bruce to Uganda to investigate sleeping sickness which, as you will remember, killed thousands of Natives and threatened the destruction of the population of the Lake country. It had already been the object of investigations, but without any satisactory results. One of the men who thought that he had finished his work—his name is of no concern at present—considered he had found the cause in some bacterium which he had isolated from the brain of dead people. He met Bruce on his arrival, and in discussing his finding with my friend, quite casually mentioned that he had seen a *trypanosoma* in the blood of some of the patients, a parasite which by that time had already been known in Western Africa under the name of *Trypanosoma Gambiense*. It was not connected with any definite ailment, and the disease was simply called the *trypanosoma* fever. "Like a flash of lightning it went through my mind," Bruce told me, "that this parasite must be the cause of sleeping sickness and nothing else, and that if such was the case, then it must be transmitted by a fly." Bruce was right. His theoretical deductions, based on his previous observations, led him immediately to the right conclusions.

Sleeping sickness was found to be the human tsetse fly disease; the fly was found to belong to the same genus as that of Zululand, *viz.*, a *Glossina*, in this particular instance *Glossina palpalis*. This being so, the further deduction that there must be a reservoir for the *trypanosoma* had to be considered. In the first instance it was found that men suffering in a mild degree from the so-called trypanosoma fever constituted that reservoir, and only within the last few years another Commission sent out by the Royal Society, and again led by Sir David Bruce, established the fact that animals, particularly antelopes, could also act as such reservoirs.

Within the last ten months Bruce has made a further interesting announcement in connection with the trypanosome disease of Nyassaland, where he is at present working. You will remember that cases of sleeping sickness have occurred there, and a *trypanosoma* was detected and described under the name of *Trypanosoma rhodesiense,* and Bruce now writes me saying that as this parasite is different to *Trypanosoma Gambiense,* the disease cannot be called sleeping sickness. This statement will help to explain many observations hitherto thought contrary to our knowledge of that disease.

The layman is, as a rule, satisfied when he knows that a disease is carried by an insect; he then understands at least the distribution and the spread of it. An explanation of the real meaning of the observations must, however, be given in order to understand the phenomena from a biological point of view. What are the trypanosomes, and what is meant by their passage from a mammal into a fly, and *vice versa?*

Trypanosomes are small animals of the protozoon tribe with a definite life-cycle only recognised in recent times. A sexual reproduction alternates with an asexual one, the former taking place within the body of the fly, the latter within the body of the reservoir, men or animals. The asexual multiplication within the animal ensures the propagation of the species, an infected animal offering plenty of opportunity for flies partaking of its blood, and subsequently the parasites present in the fly undergo a process of renovation. That such is the case has recently been shown in the laboratories in Europe.. When animals suffering from certain protozoon diseases are treated with certain drugs, some of the parasites become drug-resistant, but they lose this acquired quality as soon as they have passed through their host, that is, undergone a sexual reproduction. When explaining the life-cycle of these organisms to interested people, the question is usually put to me, "Where do they come from? The disease being only of recent occurrence, have they always been present, or do they spring up suddenly, and why?" From a South African point of view this is quite a natural question. The diseases are old ones; as already explained before, they are only new to science, and we cannot imagine that they have originated within historical times. Considering them in the light of evolution, we must accept the idea that at a far-removed period there must have been a beginning. Analogies with other parasites in other flies will demonstrate such a possibility. If we kill a common house-fly and put the contents of its stomach under the microscope, we shall, in a good many cases, detect a parasite called *Crithidium,* a flagellate resembling the *trypanosoma.* They are present in a good many species of flies, particularly in blood-sucking flies, and this being so, it is not difficult to understand how such a parasite, accustomed to a constant blood diet in the body of the fly, could find its way into the body of the animal, and from there back again into the fly. The explanation of the cycle of trypanosomes means, therefore, nothing else than a well-adapted parasitism similar to many others existing in the animal kingdom, and the mystery attached to them gives way to well-established facts.

There is another interesting point connected with the discovery of the Zululand trypanosome which should be recorded in these days, where details of research are easily forgotten. Bruce knew, from the tales of the old hunters who took their horses into the hunting fields, that horses dosed with arsenic did not so readily contract the disease. Having realised that the trypanosome was the cause of *nagana*, Bruce put the treatment to the test, and found that under the influence of arsenic the parasites temporarily disappeared out of the blood, but re-appeared when the effects of the drug had passed over. As I explained just now, the parasite had become arsenic-resistant, and further treatment became useless, but nevertheless the life of the animal was prolonged. This observation must be considered to be the commencement of the modern chemico-therapeutical investigations, where the influence of a medicine on a parasitic organism is studied microscopically, and which has resulted in the discovery of Ehrlich's salvarsan for the treatment of all diseases caused by *spirochætes*. After Bruce's publication, Professor Laveran of Paris took up the control of the arsenic treatment, which in the course of time was tried repeatedly, and altered until the successful results were obtained. I mention this as another example to show how empiric observations can be turned to useful account by an unbiassed scientific mind.

The conditions of infection and transmission in trypanosoma disease which I have explained somewhat in detail also holds good, *mutatis mutandis*, in our common malarial fever of men. I hope there are no people among this gathering who are unaware that the malarial fever is transmitted by mosquitoes, as it is a fact so well established that there is no room left for any doubt. In this disease the mosquito is the host: the parasite, called a *plasmodium*, undergoes the cycle of development in the body of the mosquito, a phenomenon which can be actually observed under the microscope. Man represents the reservoir for the virus, particularly the natives of malarial countries who, as long as they are children, harbour the parasite in their blood. It would be quite natural to ask whether animals also act as reservoirs. To this the reply is that such is not the case. There are, however, parasites belonging to the same genus present in a good many species of our birds, particularly in finches; they have also been found in a squirrel, and they are frequently found in bats and in some species of climbing apes. Since all these animals live in trees, the enthusiastic evolutionist may make a surmise as to the origin of human malaria at a very remote time. It was through the study of the blood of parasites in birds in the first instance that all the light has been reflected on to malarial fever of man, and this example should serve to illustrate in a most striking way how pure scientific investigations have led to far-reaching practical results.

It having been proved that the flies and insects act as hosts of the disease-causing germs, it was a natural sequence to draw the conclusion that the destruction of the carriers would be a means of clearing a country from disease. This has frequently been called an impractical application of a theoretical deduction. It has, however, been undertaken most seriously in many parts of the world, and the Americans have given us the example in Panama. You will remember that when the first attempt was made to build that canal, the mortality from fever, particularly yellow fever, another mosquito-transmitted disease, was enormous. The destruction of all mosquito life has now reduced the mortality to that of a European town. I regret to say that in South Africa we have been somewhat slack in making use of all this knowledge. Private enterprise in the form of an Anti-malarial Association, with its headquarters in Johannesburg, is now trying to disseminate modern knowledge about the cause of malaria and its prevention, more particularly for the benefit of those whom it affects most, and who, in the ordinary course of things, would hardly hear about it, and are unfortunately the people who least believe it.

It remains now to show you that all this modern knowledge and the discussions it led to can be usefully applied to some of the problems which are in my particular line of research, *viz.*, to diseases of our domesticated animals. I shall mention but two, known probably to you all, and which are of great economical importance—horse-sickness in equines, and blue-tongue in sheep. Long before any expert came in contact with him, the observant farmer quite rightly classed these two diseases in one group. He even went so far as to say they were identical, but here is an opinion which we are not able to support. There are nevertheless more similarities than differences in the two; they resemble each other in nature of the cause, both being due to micro-organisms of infinitesimal minuteness, so small that none of our modern microscopes can detect them. The theory of our modern microscope teaches us that there is a limit to visibility beyond which objects can no longer be recognised. The so-called ultramicroscope, which makes use of a different principle of illumination, and allows the detection of objects varying in the magnitude of a molecule, has in these two diseases failed to enable us to demonstrate an organism so far. It must be there, nevertheless, and we conclude this from the experiment that we are able to transmit the disease by inoculation with blood from a sick to a healthy animal, in which latter, after a definite incubation time, it appears, thus shewing that a development must have followed. It having been demonstrated that the malady was inoculable, it formed the subject of much speculation to explain the observations which the framers had been collecting ever since they knew it, and which principally apply to the climatical and tellurical conditions under which it appears. You have probably all heard that the farmer interpreted his observations to the effect that the dew is the cause. There is nothing ridiculous in this theory. Remember that our knowledge of micro-organisms as causes of disease is practically only a science of yesterday; remember that the English translation of the name "malaria" for the disease of that name means "bad air," and it is only a few years back that science admitted of such a theory as the probable cause; that is just as our farmers have done and are still doing for horse-sickness. The observations of the farmer are correct in details. We give them the right interpretation when we substitute for the name "dew" the name "blood-sucking night insect." Under the conditions under which dew is formed horse-sickness and blue-tongue appear most frequently, and these conditions are most favourable for the breeding of mosquitoes and other blood-sucking insects. This being so, the question might be put to us, "But are there any direct proofs to this effect?" If we had all the proofs, we would no longer speak of a theory, and we must speak of a theory until the actual blood-sucking insect has been demonstrated and until the experiments have been made under such conditions that no doubts are left any longer. Indirectly, the theory has been so well founded that the only missing link is the insect itself. The reason why this link has not been demonstrated yet is the fact that we do not know sufficient of all the nocturnal blood-sucking insects of South Africa, of which various genera and many species exist; we do not yet know how to breed and handle them for such delicate experiments as are required to bring the proofs with horse-sickness and blue-tongue. Notwithstanding this, the theory has its practical value, inasmuch as it shows in which way protective measures can be adopted, and what has been said about the destruction of mosquitoes in connection with human malaria applies equally well to the diseases under discussion. The theory goes still further. Seeing that flying insects must be accepted as being the transmitting agencies, we conclude that there also must be a reservoir somewhere from which these insects obtain the virus This is perhaps the most interesting point. The horse alone in the case of horse-sickness, and the sheep in the case of blue-tongue, is not sufficient to represent that reservoir. When recovered, the blood of these animals no longer contains any virus. Furthermore, horeses, when introduced into a wild country where before there had never been any equines, are liable to contract the disease. Again, the almost "explosion-like" expansion when climatical conditions are suitable do not allow us to conclude that the sick animal alone is responsible, and we naturally ask, "Where does the virus come from?" By analogy with tsetse and human malaria we accept the existence of a reservoir in the shape of a different species of animal, harbouring the parasite of the disease in its blood. Such an animal may be cold-blooded or warm-blooded, a bird or a mammal. Here, again, we have not yet been able to make further progress. We enter on a different branch of research It will be interesting work for our zoologists to point out to us the geographical distribution of any such animals, coinciding with the distribution of the disease. Then we might have more hope of proving the theory than there is at present, where we have to work more or less in the dark. It is this theory which justifies the hope that within the districts of the reservoir those diseases will be suppressed one day. Recently an assistant of mine, Mr. Walker, found a parasite in the blood of young ostrich chicks known under the name of *leucocytozoon* and related to the trypanosomes. Whatever the practical outcome of this discovery will be, one conclusion we are entitled to make now, and that is the parasite is transmitted by insects; and should it prove to be the cause of the mortality observed in chicks, the way to combat it is indicated by this conclusion. Whilst on the subject of suppressing disease, I wish to refer to some other well-known observations made by farmers, the correct interpretation of which has led to important applications. They are in connection with immunity. When horses or sheep recover, they are said to be salted against the disease, *viz.*, to be immune. We expected this to be so by comparison with other diseases of a similar nature, but caused by visible organisms. To this latter group belong those against which modern science introduced methods of preventive inoculation, and by analogy we were entitled to anticipate that a similar possibility would exist in connection with those under discussion. It proved to be the case, and on recognised principles, methods of inoculation for mules as well as for sheep were worked out, which proved to be successful. In the case of horses, however, great difficulties were experienced, inasmuch as these animals showed a much higher susceptibility than mules, a fact which can only be explained by inherited immunity from their sires, which, although susceptible to the disease, have, at least in my experience, never been found to die The methods in use for mules proved useless for horses. Here the observations of the farmers came to the rescue; they led to deductions which proved to be applicable in the practice.

Long ago farmers had the experience that the so-called salted horses may break down in immunity. They called these relapses, or "*aanmanings.*" Subsequently our experience proved the same observations to be correct. Some of the mules and horses which were undoubtedly immune broke down when exposed to natural infection. The virus from such cases was collected, and in several instances it was shown that breakdown in immunity could be produced in almost any salted animals. The experiments showed that there was no actual loss of immunity in the animal affected, but the relapse was due to the different nature of the virus. This means from a biological point of view, the ultravisible micro-organism will also follow the laws of other organisms, *viz.*, that of variability or mutability, but which can show itself to our eyes only by a different virulency in the animal it attacks. Accordingly more than one variety of horse-sickness organisms exist, and although from a pathological point of view we only recognise one disease, yet there are as many diseases as there are varieties of ultravisible organisms. At one time we thought that the variation was simply due to the influence of environment, but, based on a number of experiments, we came to the conclusion that the cause of the variability of a particular strain lies in the horse from which it is collected. The host represents, so to say, its environments. The passage through a horse determines whether there will be a decrease or an increase in virulency. This fact established, the further conclusion was made that there must be certain strains or varieties of which the virulency would not be so pronounced, and accordingly that a greater number of animals would recover when infected. This, indeed, proved to be the case. The variability of the organism has now been made use of for the inoculation of horses in connection with the method as applied to mules. The method was introduced into practice last year, and only in the experimental manner; it has not yet stood the brunt of the severe tests of the practice.

The experience just now alluded to teaches us that under the conditions of the practice breakdowns in immunity will occur. It remains to be seen to what extent they do occur, or, in other words, what percentage of inoculated horses will be protected against the naturally acquired disease. The same principle was made use of in the preparation of the blue-tongue vaccine, and again recently in the method of inoculation against anaplasmosis of cattle, a disease generally known as gall-sickness. This latter was found to be caused by parasites attacking the red corpuscles of the blood. The remarkable observation was made that two different varieties of organisms could be distinguished under the microscope, and the tests proved that whereas one species was very virulent, the other one was very much less so, and this latter protected an animal to a great extent against the former. The vaccines used against the various diseases therefore represent by no means anything artificial; they are specially selected germs producing the disease in a milder form, which give a great amount of immunity, but by no means a complete one, owing to the existence alongside of still stronger varieties of the same species or genus.

A cure or an inoculation against a disease always appeals to the mind of the layman, and more credit is attached to such an inoculation than to other methods of prevention or controlling the disease which perhaps are more rational but more tedious and cumbersome. A good illustration of this is afforded by red-water, which, as many of you will remember, was introduced into the Cape Colony many years ago. In those days measures were taken to stop its spread, but they were of no use, because the cause of the plague was not then known. Only in the beginning of the nineties of the last century it was found in America that it was due to a parasite which lived in the red corpuscles; the parasite developed in the body of a tick, and was transmitted by these to new cattle. This was as much an epoch-making discovery as Bruce's, that the *trypanosoma* disease was carried by winged insects. The statements of the American scientists were subsequently verified in this Colony, and when the attention of South African workers was drawn to the presence of similar parasites in the blood of South African stock suffering from various other ailments, then it was only natural to conclude that in their propagation ticks also must be responsible. The conclusion proved to be correct. It was further proved that there also existed the theoretical reservoir; it was found that it was the recovered animal itself which remained infected. This fact, so paradoxical as it appears for healthy animals to spread a disease, explains the permanency of infection on our pasture; although they are immune, they maintain the contamination. The investigations by Lounsbury into heart-water, a disease caused by an invisible organism which at one time rendered the rearing of cattle and small stock almost an impossibility, more particularly in this neighbourhood, proved definitely that also here ticks were responsible. Once these facts were well established, it was a natural conclusion to expect that the destruction of the ticks would mean the eradication of the disease, just as the destruction of mosquitoes meant the disappearance of malaria. This conclusion at one time had only appealed to a limited number of farmers, and it is even at the present time not sufficiently appreciated. Perhaps it is not scientific enough, or there is not enough mystery about it. When the terrible disease, East Coast fever, was introduced into South Africa, the presence of a parasite found in the blood corpuscles was soon recognised, and the conclusions had to be drawn that here again ticks were responsible. This also proved correct. After the species of tick which transmitted the disease had been traced, and their life-history was fully understood, and once it had been realised that in this disease, unlike the others caused by intracellular parasite, the immune animal did not represent the reservoir for the virus, it became possible to successfully combat it. In the course of time the most powerful remedy proved to be the dipping tank, which was deciedly the salvation of the Natal farmer, all other methods of stopping the spread in that Colony having failed. For the destruction of the ticks as the root of many evils in stock, the dipping tank must be considered to be the best and most practical means, and its introduction into South Africa is a great scientific attainment. The first man to make continuous use of it was the

Honourable Joseph Baynes, of Natal, a name to be remembered; and at that time he could not have realised the far-reaching effects it would have. The discoveries of the many tick-transmitted diseases have only been made subsequent to the introduction of the tank, but they all proved in turn the necessity of it if an attempt was to be made for the eradication of the diseases. The credit for demonstrating its practicability is particularly due to Lieut.-Colonel Watkins Pitchford.

Not only in the world of micro-organisms, but also in that of higher developed parasites, we shall find our example for demonstrating the utility of the adoption of biological research I refer to one of the most important farming industries, *viz.*, the breeding of ostriches. We know that one of the main drawbacks are internal parasite, and although the farmer is able to help himself temporarily in a rough and ready way, yet he feels that, in order to combat these pests more successfully, more scientific knowledge is required about the life-history of these worms. As soon as this is established—and I can tell you that good progress has already been made in this connection—practical deduction will be possible in order to build up a rational hygiene for the rearing of the chicks.

So far I have selected my examples in scientific research and practical application out of a group of disease due to parasites visible to the naked eye, by microscope, or those that can be traced by means of inoculation experiments. We have, so to say, the cause of the diseases in our hands, and can produce and reproduce them at will. This is the one and perhaps the main reason why in the past, in a considerably short time, good progress was made; we were dealing with problems simliar to many others already solved. I will now have to mention a subject where the use of the microscope and all transmission experiments into animals failed. It is the disease "Lamziekte" in cattle, to which, in recent years, so much attention has been given by the public, the press, and Parliament. It has caused terrible destruction, and even threatened to ruin the newly-developed north-western districts.

The investigations carried out so far in conjunction with Mr. Burtt-Davy, the Government Agrostologist and Botanist, show that we have to deal with toxins which are present in grasses of certain areas. This is at least our theory, and it is well founded; it is, however, by no means new, as it has tis analogies in other parts of the world, and explains the observations made by farmers in various parts of South Africa; indeed, it represents the views of many farmers, although not precisely expressed. It is that grasses on certain soils and under certain climatic conditions develop a poison of an accumulative character which only shows its effects on cattle after they have partaken of such grasses for a prolonged period. Actual feeding experiments which have been started on various experimental stations will bring the proof one of these days. The influence of climate and soil has also recently been brought home by experiments undertaken in Natal. Some of you will remember that Mr. Robertson, of Grahamstown, proved in an unmistakable way that the plant *Senecio latifolia*, collected in that part of the country, proved to be very fatal when fed to horses and cattle The experiments in Natal, carried out on the same class of animals with the same plant, proved harmless.

You will grasp the complexity of these subjects when you remember that, in order to fully understand and explain them, a combination of a number of sciences is necessary, *viz.*, Pathology, Geology, Botany, Chemistry, Climatology, Meteorology and Physiology. Better subjects could hardly have been found to illustrate how comprehensive investigations may become in a matter which at first sight seems purely and simply a problem for the veterinarian. This point brings me back to some remarks raised before. It is only possible for an applied science, such as that for investigating into the cause of the disease, to progress when the other sciences on which the applied one is based are advancing at the same time or, still better, are ahead of it. This applies strikingly to the case in point. Of the physiological effect of grasses and plants under the various conditions of climate and soil in South Africa we know nothing as yet. I am glad to state that the Minister of Agriculture, to whom I have explained the necessity of such investigations, has promised to add a branch for physiological research on to the laboratory under my control. But an investigation of this nature must be thoroughly undertaken, and in order to be fruitful it must go hand in hand with chemical and biological investigations of the nature of the soil as well. The necessity for such investigations has frequently been pointed out. Professor Pearson some years ago advocated the erection of botanical gardens in South Africa in areas representing the various conditions of climate and soil, and one of his strong arguments was the economical importance such establishments would have. Our recent investigations bear him out, and should bring home the value of such institutions. For many years Dr. Juritz preached the necessity of a systematic and thorough chemical survey of the soil of this sub-continent. In his recent presidential address to the Chemical Society, he clearly pointed out that, so far, investigations have not been undertaken as necessity demanded, and I fully endorse these remarks. The conclusions I put before you in connection with the disease caused by plants show you the necessity in the first instance of scientific research into soil and vegetation. But a good deal is required if we intend to make further progress in the understanding of the disease as already described, and of many more not touched on at all. The necessity for a general biological survey of all South Africa becomes obvious. Particularly the geographical distribution and seasonal occurrences of plants and animals, the connection between climate and soil with flora and fauna, will have to be thoroughly studied. Hand in hand with this will go the interpretation of the presence and absence of the cause of cerain stock diseases. Fortunately, in the past a great deal has been done by a good many enthusiastic workers. I do not mention any names, for fear that I might do an injustice to those whose names I might forget. More has yet to be done. Dr. Muir, in his presidential address in Cape Town two years ago, touched on this question, and he pointed out the necessity of a systematic co-operation in which the museums of South Africa could perform the leading duties. I fully agree to this, and I am of the idea that these institutes, similar to the one under my charge, should be centralised, and the work should be undertaken in a definite and well-planned manner, preventing overlapping, and securing complete specialisation in the various branches. We require more: we want a centre for scientific investigation, a central University for South Africa, where research is the leading idea. I speak with emphasis, that South Africa should not wait any longer before establishing such an institute. We men engaged in the application of science feel the want of it in all our undertakings; we require it for advice or assistance in the many problems the solution of which is entirely outside the scope of a single man who is not always able to keep in line with the new discoveries, and outside of his own sphere of work. Now-a-days, it is no longer a genius who will only be capable of solving knotty problems; I venture to say that the methods of investigation and research are so far developed that any scientifically trained man with the necessary critical mind, and endowed with patience and perseverance, can tackle these investigations with every prospect of solving them, provided the sciences he has to make use of are sufficiently far advanced as to be of assistance to him. It should not be necessary to go out of South Africa in order to obtain the assistance of such sciences.

In conclusion, I wish to come back to one of my remarks; that the South African tends to the practical side of scientific problems. If I can give him, after so many theoretical discussions, practical advice, it will be: foster by all means the pure sciences; they are, in the hands of experts, the medium of solving the many economical problems of South Africa.

Section A.—ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE, AND GEOGRAPHY.

President of the Section.—H. J. Holder, M.I.E.E.

WEDNESDAY, JULY 3.

The President delivered the folowing address:—

RECENT DEVELOPMENTS IN ELECTRICAL ENGINEERING.

In making my first appearance before you to-day, which I do with much diffidence, I wish to express a sincere appreciation of the honour done me, and to say that I shall endeavour to merit the confidence placed in me by taking a full interest in the work of this Association and by adding, if I can, some modicum of knowledge to its garner.

My everyday work and the duties of my office are, as you may be aware, of a practical nature, and consist, for the most part, in the application of electrical science, which has been elaborated by others, to industrial and domestic needs. I cannot, therefore, expect to be able to devote much time to follow along lines of original enquiry, and have consequently thought it best, for the purpose of this address, to take a brief review of the progress made in engineering—especially the electrical branch of it—during the last decade or two.

The first instance of public electric lighting in England was the lighting of the Victoria Embankment on December 13th, 1878, but electric lighting really dates from the Paris Exhibition of 1881. In those days the plant used was of small dimensions, being of only from 10 to 20 kilowatts' capacity, and the dynamos were driven by slow-speed steam-engines of the horizontal type. The appearance of the dynamo, which was required to be driven at a comparatively high speed, began soon to make itself felt as regards the design of steam-engines, whereby the slow-speed, belt-coupled engine gave place to the high-speed, short-stroke engine which was coupled direct to the shaft of the dynamo Engine speed had to be increased to suit the dynamo. The next great step in steam engineering was the production of the turbine by the Honourable Chas. Parsons, which was of so high a speed that it was found to be very difficult to design a satisfactory continuous current dynamo for it. Indeed, even now the turbo-dynamo is not nearly so satisfactory a set of machinery as the turbo-alternator is, but the former is being rapidly improved. The economy of electric generators driven by reciprocating steam engines, expressed as the ratio of the energy in the coal to the electrical energy produced, may be taken as a maximum of 10 to 12 per cent., while large turbines of the latest design have brought up the efficiency to about 18 to 19 per cent.

The development of the steam turbine in central station service has been etremely rapid. In the year 1903 several 500 K.W. steam turbines were erected in the Great Fisk Street Station of the Commonwealth Edison Company of Chicago, but these were speedily replaced by 1,200 K.W. units, and one of the original turbines was erected in the centre of the park of the General Electric Company at Schenectady as a memorial of the rapid development of the turbine. Quite recently Messrs Parsons have contracted to build a turbo-alternator of 25,000 K.W. capacity for this same station, so that in nine years the size of the turbine has increased fifty fold. This large generating unit is expected to show an improvement in steam consumption of 10 per cent. compared with the best existing plant, and this seems to point to the direction development in electrical generating plant is likely to take for some years to come.

Very great difficulties occur in the development of internal combustion engines of large size, and it is unlikely that they will be employed to any appreciable extent for use in central electricity supply stations until a satisfactory rotary type can be evolved, and the difficulties in the way of this type are perhaps greater and involve many problems, such as the finding of a material that will stand very high temperature without losing its tenacity.

For plant of from 500 to 1,000 K.W. size, and smaller, the internal combustion engine will doubtless continue largely to be used.

Among other prime movers which have a promising future before them, the Diesel oil engine deserves to be mentioned, more especially as this engine approaches in efficiency more closely to the ideal or perfect heat engine than any other Almost any kind of oil, whether animal, mineral or vegetable, can be used effectively in this engine. Some few months ago experiments were carried out in the Congo for the French Government to ascertain whether it was feasible to utilise the oil obtained from "monkey" nuts in this engine, and I am informed that the results were very satisfactory indeed, and such as to render the engine particularly useful in tropical countries where coal is expensive and "monkey" or ground nuts can be grown cheaply.

The Shuman sun-power plant is another prime mover which may be developed for use in tropical climates, especially since it is held that 10 per cent. of the earth's land surface will eventually depend upon sun-power for all mechanical operations. This plant consists of an absorber, a low-pressure steam-engine, condenser and auxiliaries. The absorber is composed of a series of units, each containing a flat metal honeycomb water vessel, rectangular in shape. This vessel is enclosed in a flat wooden box covered with two layers of glass having a 1-inch air-space between them, and having the under surface of the box insulated against heat loss downward by a 2-inch layer of granulated cork and two layers of waterproof material The boxes are mounted on supports which elevate them some 30 inches from the ground, and which permit them to be inclined normal to the sun's rays at the meridian. These adjustments of the inclination need only be made once in three weeks. There are plane mirrors of cheap construction mounted on two sides of the boxes in order that more rays of the sun may be absorbed and reflected upon the surface of the water vessel. The vessel is connected at one end to a feed pipe from the water supply, and at the other end to a steam pipe. The steam pipes of the various units are connected together, and empty into a steam main which conveys the steam to the engine.

A plant of this nature has been set up in Philadelphia capable of developing 4,825 lbs. of steam at atmospheric pressure during eight hours. The capacity of the plant is estimated to be three times this amount when it is finally set up in Egypt, as intended.

According to Sir J. J. Thomson, the radiant energy of the sun in tropical countries amounts to 7,000 H.P. per acre. There is therefore great chance for sun power in those tropical regions where the sun shines almost throughout the year and fuel is expensive. There is room now for half a million horse-power in the nitrate district of Chile, and for general purposes in places where the outside temperature runs from 110 to 140 degrees.

As an irrigation engine, it is claimed that there is no limit to the amount of power that can be practically utilized. One advantage of sun power or, in fact, of any condensing plant for irrigating purposes is, the water used for the condenser costs nothing, as the main output of the engine can be passed through the condenser before entering the irrigating canals.

The water-power of the world is being rapidly developed, and is transmitted and used electrically. I find it recorded that in the region bounded by the Alps, the Rhine and the Mediterranean—an area of rather more than 2,000 square miles—there were, in June of last year, hydro-electric stations of an aggregate capacity of 475,000 H.P. at work, while in a Board of Trade report issued in January last it was stated that 490,000 H.P. was being used in Norway, and that work is proceeding for the utilizing of a further 430,000 H.P., while a still further 200,000 H.P. has been applied for, bringing the total to well over 1,100,000 H.P.

In the New World much water power is being developed. I have not been able to ascertain the extent, but a list of thirty-three undertakings in Canada, Mexico, California and the United States of America which I have gives a total of 1,178,000 H.P.

Scotland is estimated to possess over 1,000,000 H.P. of water power, and it has been pointed out that if the figure is halved it would still represent, on a 10-hour working day basis throughout the year, an amount of power equal to that obtained from 3½ million tons of coal. Of course, considerable expense would have to be incurred before this power could be utilized, but the Kinlochleven installation, which provides for an output of 30,000 H.P., has cost about £20 per H.P., which is a low capital cost. Electric power derived from water has been publicly advertised for sale as low as 30s. per H.P. per annum.

In this country there is comparatively little water power available, but it is surely astonishing that a portion, at least, of the 300,000 to 600,000 H.P. of Victoria Falls has not yet been utilized. Even the electric light for Victoria Falls Hotel is still being furnished by an antiquated steam plant.

For agricultural purposes, more especially irrigation, one would expect that a very considerable amount of power could be utilized within a radius of 300 miles of the Falls, and doubtless developments in this direction will take place.

In the matter of the transmission of power electrically, one may mention that less than a year ago there were only some half-dozen systems in operation where a pressure as high as 100,000 volts was employed, but an undertaking has lately been completed near Lake Huron employing a pressure of 140,000 volts, and the line has been in successful service since March last. The limits of practical voltage have been given by various engineers who think they know what may be ultimately feasible; some put the practical working limit of the future as low as 200,000 volts between conductors, but there are others who firmly believe 300,000 volts will be used; while, if the limit can be pressed up to 500,000 volts it will be possible to couple most of the power stations in the United States of America together, and so be able to even up the load between them.

Improvements in the methods of producing aluminium, coupled with the reduced cost of electrical energy used, has had the desirable effect of reducing the price of this metal to a figure approaching that of copper, and this means that at present an aluminium aerial line of large capacity is considerably cheaper than a copper one. Near the sea coast, however, aluminium is attacked by the salt-laden atmosphere, since the metal has a great affinity for chlorine, and it is rather doubtful whether it can be profitably used in such districts. In Canada, United States of America and Scandinavia, aluminium has been very extensively used for electrical aerial transmission lines, and there are also quite a number of small aluminium lines in use in England and Scotland.

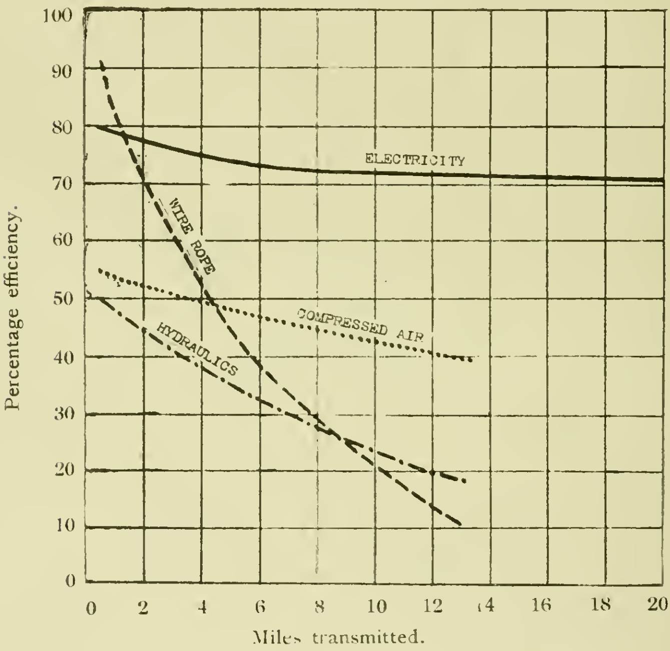
The diagram, which has been plotted from a table of efficiencies in long-distance transmission given by Beringer, shows in a striking manner the unique position occupied by electricity in the transformation and transmission of energy.

A philosophical deduction of great importance may, as shown by Lineham, be deduced from a consideration of this diagram.

In wire rope solid parts are transmitted, and the efficiency falls off rapidly; hydraulics transmit liquid parts, and the efficiency is better maintained; pneumatics transmit gaseous parts, and the efficiency is considerably better; but the best results by a great lead is obtained by electricity, where a total over-all efficiency of 70 per cent. has been proved over a distance of 100 miles.

COMPARISON OF EFFICIENCIES IN LONG DISTANCE TRANSMISSION.

(AFTER BERINGER.)



These facts indicate the electric current to be either vibrations of the ether or the passage of a highly attenuated substance.

We have roughly sketched the progress made in the means and methods for the conversion of heat and kinetic energy into electrical energy, and it may now be interesting to take some note as to how the energy so converted is being used. Electricity from central stations was first used for lighting, but from the general trend of development it would appear that much more energy will eventually be used for either heating, power or electro-chemical purposes than for lighting. Much of the enormous power now being developed from waterfalls is being used for the production of nitrous compounds from the atmosphere, for the electrolytic deposition of metals such as copper, for many synthetical chemical processes, for the smelting of iron and other metals, and for the manufacture of special steels.

The latest process for the production of nitrous compounds is the invention of Messrs. Schoenherr and Haszberger, and is being introduced on a very large scale in Norway. In this process the air is passed through an iron tube in which an alternating-current arc of 5 metres' length is maintained under a pressure of 4,200 volts; the air enters at one end of the tube by a series of tangential holes, and the rotary motion thus produced keeps the arc confined to the axis of the tube. Each arc requires 600 H.P. The inventors claim a greater yield of fixed nitrogen than is obtained under the Birkeland-Eyde method, and a compound richer in nitrogen—namely, 18 per cent., against 13 per cent.

The owners of the patent, who have amalgamated with the Norwegian Nitrogen Co., propose to erect large works in the western parts of Norway, which, when completed, will utilize about 400,000 H.P.

The electric furnace has now passed the experimental stage in Norway and Sweden. At the present time there are four furnaces at work in Norway, and the same number in Sweden for the smelting of iron, the largest being of 4,000 H.P. Owing to recent improvements in electrode manufacture and furnace design, it is now possible to construct furnaces up to 6,000 H.P., which will work for two years without needing extensive repairs to the hearths. In Sweden there is no doubt that the electric furnace has come to stay on account of cheaper production, and because it is especially adapted to the smelting of finely divided ores and concentrates. Electric smelting in Sweden has a national value, inasmuch as its adoption will result in the development of water powers which could not, in many cases, be profitably utilized for any other purpose.

An electric furnace was started in Sheffield in March of last year, and analysis has shown the steel from this furnace to be of excellent quality, which by test equalled the highest-class crucible steel.

An undertaking has recently been formed in Norway with the object of establishing an industry for converting iron and steel scrap from broken-up vessels into high-grade steel by means of the electric furnace, and a movement of a similar nature has taken place in South Africa.

Electrolytic refining of zinc has been pushed forward by the Japanese, especially by Mr. C. Yoshida, and the process has been very successful.

The increasing use of electrical energy for motive power in factories is indicated by the figures taken from the annual returns of the horse-power of motors connected to the mains of the electrical supply undertakings in Great Britain and Ireland, as published by *The Electrician*. Although the figures are not complete, a number of undertakings giving no return, and the large power companies not being included, an addition of 70,000 H.P is accounted for, bringing the total horse-power of motors known to be connected to public supply mains to over 630,000.

Electricity has of late years been increasingly used for traction purposes on railways. Up to March of last year about 800 miles of line in Europe and America were being operated by high-pressure continuous current, the longest line being an American one of 90 miles. I am unable to say the extent to which alternating current is being used or the length of the lines so operated.

The Prussian House of Deputies has adopted a proposal to spend £2,500,000 on further railway electrification, and the Chilian Government is considering the electrification of over 6,000 miles of railway, energy for which is to be water-power generated.

The very satisfactory results which have hitherto been obtained from the employment of electricity for traction on railways in all parts of the world is bound to lead to tremendous development in the near future.

Another form of electric traction which has met with success quite recently is what has come to be known as "rail-less" traction. This system was first tried in England at Bradford and Leeds, where the formal opening of the new service took place on June 20th of last year. Since then several other municipal bodies have decided to adopt the system, mostly as extensions to their existing tramways.

The improvements in electric lamps, both of the arc and incandescent type, during the last few years must not be allowed to escape notice. In both kinds of lamp the efficiency has been enormously increased, and, as a consequence, electric light has been greatly cheapened. For these benefits we have to thank the chemist more than the engineer.

Whereas the efficiency of the early incandescent lamp was one C.P. per 4 watts, it is now one C.P. for 1¼ watts. The useful life of incandescent lamps has also increased.

When we consider the growth of electricity supply in the various countries, to the great proportion of its present-day attainments, in so short a period, and the ever-increasing uses to which electricity is being put, one may be forgiven for anticipating that, great as the progress has been, it will be trifling compared with what it will be in the years to come. Already we have in most countries numbers of huge power supply systems being developed over enormous areas, and we may anticipate, with Mr. Ferranti, that electricity will eventually become the chief agent in the material progress of the world.

The time at my disposal has been sufficient to refer to only a few of the industries which have benefited by the application of electricity, but when one reflects that almost every industry has been assisted by the use of electricity in one way or another, one begins to perceive that an enormous field of usefulness is open to this versatile agent in the service of man.

Section B.—CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY AND GEOGRAPHY.

President of the Section.—Prof. B. de St. J. van der Riet, M.A., Ph.D.

TUESDAY, JULY 2.

The President delivered the following address:—

THE NEED OF A SURVEY OF AGRICULTURAL SOILS IN SOUTH AFRICA.

In selecting the subject on which I have the honour to address you, I have been influenced by the firm conviction that the attention of our scientific men and of the general public should be directed to the question of how best to promote agriculture in South Africa by means of scientific work, particularly in chemistry and geology. If anyone who takes an interest in the analysis of soils will inquire what is being done at present in the way of extending and developing the investigations initiated by Dr. Juritz in Cape Town eighteen years ago, he will learn that there is no systematic soil survey in progress; that co-ordinated investigation in agricultural chemistry is apparently non-existent in our Government laboratories; and that the laboratories themselves, as regards room accommodation and equipment, are unsuited for the work which should be done in them.

Before proceeding to the main subject of my address, which will deal with the need of a systematic survey of agricultural soils in South Africa, allow me to diverge for a moment in order to say a few words in appreciation of the interesting work entitled "A Text-book of Rand Métallurgical Practice, vol. i.," which has recently been published. The authors of this manual (Stokes, Thomas, Smart, Dowling, White, Johnson, Caldecott and Johnston) have brought together in a compact and lucid form a fund of useful information regarding prevailing practice and policy on the Witswatersrand gold-mining area. To quote from the preface, they have produced

> "'a working tool' for those concerned in each branch of ore reduction and treatment practice, and a guide to fellow-workers operating under similar conditions in other parts of the world."

Their book, which is written chiefly for specialists in metallurgy, should appeal to many in South Africa who are not directly interested in mining. It is of value not merely because of the *facts* it contains, difficult though it certainly is to obtain such full and reliable data on any South African subject; the authors may be said to have given, within a brief compass, an illuminating review of the present-day phases of an ever-developing and ever-progressing industry, no longer a gamble for sudden and fortuitous wealth, but now a fine example of the strenuous application of science by man in his endeavour to earn an honest livelihood. In short, gold-mining on the Rand has become a settled industry, as settled as agriculture, although in many respects the conditions under which these industries are practised are widely different.

In dealing with the question of soil analysis, the chemist is struck by the contrast between the attitude of the farmer towards chemical analysis in general compared with that of the miner towards assaying. The agriculturist is in most cases content to proceed in his own way and, in most countries, not merely in South Africa, frequently this means that he takes little or no account of chemical analysis. The miner, again, or, to be more precise, the metallurgist, continually employs most exact chemical methods for testing his ore and the various products derived from it. The position of the prosperous farmer appears to be that he does not see the need of analyses when he can get on well enough without them. On the other hand, when crops fail and the earth does not yield an increase, it is easy for the farmer to lay all the blame on some cause, drought for instance, which may plausibly be considered a matter beyond human control. No doubt there *are* occasions when the most capable and progressive farmer has reverses of a serious nature. With regard to drought, it may be as well to recall the remarks made by Ingle * :—

> "In some countries of limited rainfall it is found that the crop which can be raised from soil extending over large areas is mainly conditioned by the amount of water which the plants are able to get rid of by transpiration from their leaves, and this in turn depends chiefly upon the amount and distribution of the local rainfall during the period of growth. If, however, one soil is richer in plant food than another, it will be able to supply a crop with sufficient nutriment with the consumption of much less water than would be necessary for the same yield in the case of the second soil. Thus the maintenance of a sufficient supply of plant food in the soil may be of more importance in countries of limited rainfall than in wetter climates."

The question then arises, What constitutes this *sufficient supply of plant food* in South Africa for any particular crop in any given soil? How is the soil-chemist to answer this question? It is true that we have at our disposal, thanks chiefly to Dr. Juritz in Cape Colony, and to Mr. Ingle in the Transvaal, a certain amount of valuable information. Dr. Juritz's book, "A study of the Agricultural Soils of Cape Colony," teaches us that the virgin soils of the more humid districts of Cape Colony are usually poor in plant-food, as judged by European standards, while Mr. Ingle's paper† indicates that the same general statement

* "The Soils of the Transvaal from their Chemical Aspect," B. Ass. Rep., 1905, p. 118.

† Brit. and S. Afr. Assns. for Adv. of Sc., Reports, 1905, vol. i., pp. 115-152.

holds for most of the Transvaal soils analysed. Nevertheless, on comparing analytical data with actual field results, Mr. Ingle remarks :

"An English analyst would be inclined to condemn the soils as of poor quality. Yet in many cases such soils prove of great fertility, and yield abundant crops."

The plain fact that stands out clearly from the work that has so far been done is that in South Africa we have still to ascertain the standards of sufficiency of plant food. All the analyses (of about 1,200 soils) that have so far been made supply only a small part of the information needed by the soil analyst before he can arrive at standards or " types " on which to base advice of practical value to farmers. It is not sufficient for the farmer to know that his vineyard, say, needs lime as well as other fertilizers to increase the acidity in his grapes, and so ensure proper fermentation of the juice, although this alone is something worth knowing. The farmer needs to know *how much* lime exactly is needed, consistent with economy and the best results. Again, it is not sufficient for the farmer to have the chemical analysis of the surface soil 12 inches deep. What cultivated plant in South Africa, where the surface soil may be baked by a semi-tropical sun, is independent of the soil below a depth of 12 inches ? And yet most of the 1,200 soil analyses referred to above take no account of the subsoil.

No one is more conscious of the need for more extended work than are those whom we have to thank for the pioneer investigations already accomplished. Dr. Juritz has been able to trace some important relations between certain groups of soils and the geological formations from which they have been derived. This constitutes the first attempt at distinguishing " soil types " in South Africa. He has himself earnestly pleaded the need of further investigations again and again, and it appears to me a matter of great urgency that Dr. Juritz should be placed in a position to develop and extend the important work in soil analysis which he has carried on under adverse circumstances for a number of years.

In South Africa, where geological formations exhibit a certain sameness of character over considerable areas, it is not surprising to find that there are widespread soil deposits which, speaking broadly, show a corresponding uniformity. Thus geological considerations *must* play an important *rôle* in the matter of discriminating distinct types of soil. On p. 158 of his book Dr. Juritz shows that a number of soils on the Malmesbury Beds exhibit an all-round poverty in plant-food, with an average for *all* the soils as follows:—Lime, .079 per cent.; potash, .124 per cent.; phosphoric oxide, .039 per cent. Whereas, if *two* of the soils from the farm Hooge Kraal be omitted, the average falls to .039 per cent. of each of these constituents. These two exceptional soils show: Lime, .358 per cent.; potash, .719 per cent., and phosphoric oxide, .041 per cent.

Now, the superiority of these two Hooge Kraal soils can no doubt be traced to the presence on the farm of certain igneous rocks of basic nature. It is known, at any rate, for certain that such rocks occur as local intrusions in the Malmesbury Beds in that neighbourhood. This instance is cited to show the close relation between geological conditions and the results obtained by chemical analysis.

But in setting up standard soil types the chemist has to go further than take into consideration geological origin and chemical composition. There are important physical characters—texture, depth of soil, nature of subsoil, and conditions regarding underground water-supply. In short, there are no important considerations which will affect the welfare of the plant which may be left out of view in establishing a number of types of soil for purposes of comparison and contrast.

The response of each particular type of soil to fertilizers of different kinds, and its behaviour under the vicissitudes of the climate of its locality, are examples of important data which it must be the object of a soil survey to ascertain. It is not suggested that the analytical chemist should work single-handed. He should gather all possible information from practical farmers, and his work should be carried on conjointly with that of the Agricultural Colleges of the various provinces. Moreover, there are biological problems in connection with soil investigations which offer a most important field for research. The many-sided question of plant nutrition cannot be dealt with merely from the point of view of one science only, and it is only by patiently combining forces in attacking the problems that present themselves that scientific men can hope to proceed onward, bearing in mind that success came slowly even to men like Liebig and Pasteur.

In what I have said regarding the necessity of a systematic survey of agricultural soils, with the definite object in view of establishing *types of soil*, I have merely endeavoured to emphasize what was suggested by Mr. A. D. Hall * in 1905, and his words are worth quoting here:—

"What the soil analyst can do is to characterize the type, ascertain its normal structure and composition, and correlate its behaviour under cultivation, its suitability for particular crops, and its response to manuring in various directions. Thus an unknown soil may by analysis be allotted to its known type, deviations from the type can be recognised, and conclusions may be drawn as to the connexion of their defects.

"Valuable as recent developments of soil analysis may have been, ... the results they yield can only be truly interpreted when they can be compared with a mass of data accumulated by the use of the same methods on known soils.

"One of the services, then, which the farmers in every country may very properly expect from the scientific man is such a survey of the principal soil types, affording the necessary datum lines by which the comparative richness and poverty of any particular soil may be gauged. In an old settled country like the United Kingdom such a survey would guide

* A. D. Hall, "Recent developments in Agricultural Science," Brit. and S. Afr. Assns. for Adv. of Sc., Reports, 1905, vol. i., p. 106.

the farmer in his selection of manures; in a new country the advantages would be even more apparent, as the areas appropriate to particular crops would be indicated."

I have referred above to the conservative tendency which appears to characterize the farmer in all countries, and have even ventured to draw a comparison between the farmer and the metallurgist. I trust that my later remarks will have made apparent the real difficulty which has to be faced by the chemist when trying to advise the farmer—the lack of established soil types.

A very interesting illustration of how the problem has been faced in the past is afforded by an article by Mr. John Muller in that valuable periodical the *Cape Agricultural Journal,* February, 1909.

Mr. Muller was called upon to investigate the cause and suggest a remedy for the yellowing of citrus trees in a well-known orchard at Blauwkrans. The Government entomologist had suggested that the cause of the trouble was gradual impoverishment of the soil. Accordingly Mr. Muller undertook a most thorough inquiry into the chemical composition of the soil and subsoil, and also of yellow and green orange leaves. Then, from known data regarding chemical composition of the fruit and the weight annually removed, he arrived at an estimate of the proportions of different fertilizers which should be returned to the soil in order to restore the balance required for healthy growth. The owner of the citrus grove was thus, at the country's expense, placed in possession of information which, as far as I can gather, has been of service to the citrus plantation. The point which I wish to emphasize is that the labour entailed in this particular instance was very great, greater, perhaps, than was justified in the case of one particular orchard, unless the results could be correlated and applied on an organized plan to other orchards as well

While advocating the need of further investigation of the soils of this country, I feel that there is occasion to utter a protest against the laboratory conditions under which the Government analysts work in South Africa. I have personal knowledge of three of these laboratories in important centres, and I have no hesitation in condemning all three of them. The Pretoria laboratory is a wood and iron structure, the Cape Town laboratory is badly lit and badly ventilated, the Grahamstown laboratory is an adapted school-building. Not one of them is suited to the requirements of a modern laboratory for agricultural research and, such as they are, the work of soil analysis is crowded into corners.

The Union of South Africa is acting in the matter of accommodation for its analytical work like a man who builds a magnificent front to his house, with ornamental furniture of costly description, while his kitchen is a lean-to under corrugated iron, alternately too hot and too cold, draughty, dusty and uncomfortable!

There is at present noticeable in many districts of South Africa a great revival of prosperity among our farmers, and no doubt this welcome state of affairs may be attributed to favourable market conditions, good seasons, and, above all, to increase of intelligence in the farmer himself. Farming with brains has led to success in many cases. There is thus every reason to hope that the farmer will be quick to avail himself of sound advice from the analyst in matters regarding soil treatment. But advice that is of real practical value must be based on years of patient and thorough work in South Africa. One looks back with sorrow to the examples which the past provides of scientific men placed in responsible positions at the Cape only to be treated with contumely because they did not instantly fulfil exaggerated expectations. The following quotation, from the *Wynberg Times and South African Agriculturist* is an example of the false kind of impression that was conveyed to farmers as to what a scientific man could do for them in a short time:—

"It is the turn of the tide for the farmers, the backbone of the country, this creation of an agricultural department with a permanent head, and it behoves every patriot to watch the selection of the Ministry, as, if an unsuitable man be chosen, there will be no satisfactory results, and the cry will arise that all fostering of agricultural development under the ægis of Government is a fraud and a sham and useless expenditure, and farmers will become more conservative than ever; whereas if an efficient, enthusiastic and energetic man like Professor Fischer is invited to accept the appointment of Secretary (and we have good reasons for saying that he would accept and enter upon the task at once), and is aided in the carrying out of his arduous duties by practical men, there will be visible such progress in all branches of agriculture that even the expectations of the most sanguine will be realized and farming will be placed on a sound, substantial basis." *

In the twenty-five years which have passed since these words appeared in print the Agricultural Department of Cape Colony has passed through many stages, and I trust that when the history of that department comes to be written due recognition will be accorded to the soundness of the lines on which it was first organized by the late Professor A. Fischer.

The Department of Agriculture of the Union is now doing magnificent work in supporting research, for example, in veterinary science; but much remains to be done in certain other directions, and it can hardly be said that the Division of Chemistry has been placed on the footing which its great importance demands.

The work entailed in soil analyses is certainly monotonous in character, and few analysts undertake such labour from choice. It is to be hoped, therefore, that the enthusiasm of an officer like Dr. Juritz, who has shown special inclination and ability in this direction, will receive due recognition, and that the much-needed soil survey will be started under his direction in the near future.

Carried out with thoroughness, the details of a soil survey become interesting to those engaged in it. This can hardly be said of isolated analyses, limited in value as compared to the labour spent on them, so that the analyst himself is doubtful as

* *Wynberg Times*, June 11th, 1887.

to their general application to the needs of the country. It may be as well to consider in this connection what Sir William Ramsay* has said as to the advisability of useful research:—

"Nothing is so sad as to see much time and labour spent, with patience and devotion, in the investigation of some matter which possesses no real importance. It may be retorted that every true statement is of importance, but this is not so. It is only statements which hold forth some prospect of contributing to an organic whole which can be held valuable. There may, perhaps, be a little more merit in ascertaining to the hundredth of a degree the boiling-point of sulphur than of measuring the area of the wings of some particular butterfly; but the difference is barely appreciable. One is as likely to prove useless as the other. It would be well if enthusiasts anxious to carry on research would remember that it is much more stimulating to carry on an interesting than an uninteresting research."

* Sir Wm. Ramsay, Introduction to Stewart's "Recent Advances in Physical and Inorganic Chemistry."

Section C.—BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE, FORESTRY, PHYSIOLOGY, HYGIENE AND SANITARY SCIENCE.

President of the Section: F. W. FitzSimons, F.Z.S.

TUESDAY, JULY 2.

The Pesident delivered the following address:—

SNAKES, THEIR VENOM AND THE TREATMENT OF SNAKE BITE.

In the course of this address it is my intention to present merely a synopsis of the subject. The subject of snakes, their venom and the treatment of snake bite is a large one, which I have found has taken a volume of over 500 pages, with upwards of three hundred illustrations, to treat of fairly fully.

Snakes have evolved from lizards, or lizard-like creatures with legs. We have to-day in South Africa living types of lizards in the various transitional stages. Some have long snake-like bodies with four small legs, which are almost rudimentary. Others have only one pair of tiny legs, which are quite rudimentary, and are fast disappearing. Others, again, as, for instance, the *Acontias meleagris,* are devoid of legs. These lizards are commonly mistaken for snakes.

The lowest families of snakes are the Blind Burrowing Worms (Typhlopidæ and Glauconidæ). Naturalists in the past hesitated to classify these creatures as snakes. They were commonly thought to be lizards.

The South African Python (*Python sebae*) is a living example of the evolution of snakes from reptiles possessing legs. The Python has two horny spurs near the vent. These are vestiges of legs, for, on dissection, it is found that immediately beneath, and buried in the flesh, are the leg bones, proving conclusively that the ancestors of Pythons had legs.

The Python is one of the giant snakes. Its remote ancestors were doubtless far more bulky. The Python and its close relation, the Boa, are non-venomous. They kill their prey by constriction. The powers of constriction the Python is able to exert are enormous. A ten-foot South African Python recently constricted the body of a lady, causing grave internal injuries although it gripped her only for a few moments.

Pythons as a general rule, are inoffensive snakes, and unless attempts be made to capture them, they rarely show any disposition to attack man. The Python is a very useful snake, for it devours considerable numbers of rats, and is the chief enemy of the large sugar-cane-eating rodent known as the Cane Rat (*Thryonomys swinderenianus*).

There are three great divisions or classes of snakes, viz., the Aglypha or solid-toothed snakes: These are all non-venomous. Most, but not all of them, kill their prey by constriction. The second division is the Opisthoglypha or Back-fanged snakes, all of which are venomous to a greater or lesser degree. These snakes have the poison apparatus in a transitional condition of development. Some of this group have recently been shewn to be as highly venomous as the dreaded cobra. The third division is the Proteroglypha. The snakes of this group, without exception, possess the poison apparatus complete, and the fangs are set in the front of the upper jaw.

The Mole Snake and the House Snake (*Pseudaspis cana,* and *Booaon lineatus*) are types of the non-venomous (Aglypha) kinds.

The Boomslang (*Dispholidus typus*) and the Herald or Red-lipped snake (*Leptodira hotambœia*) are examples of the Opisthoglypha or Back-fanged group of snakes, and the Puff Adder and Cobra are types of the Proteroglypha or front-fanged division.

There is no sure way of discovering whether any unknown snake is of the harmless or venomous class except by the careful examination of its teeth. Of course anyone can soon become familiar with the appearance of the different kinds or species of snakes and may identify them at a glance. The harmless division of snakes do an immense amount of good, for the majority of them subsist chiefly upon rats and mice. The agriculturist has a valuable asset in the many harmless or non-venomous snakes of this country. Unfortunately, all snakes are alike to him, and are killed at sight. A House Snake (*Boodon*) is far more useful in a house than a cat, for it can pursue the rats and mice to their innermost haunts, and even dispose of the young rodents in their nests.

There are a considerable number of species belonging to the Back-fanged or Opisthoglypha division of snakes in South Africa. Until lately this group has been regarded as only venomous to a slight degree, and none of the species was considered to be in any way dangerous to human life.

However, four years ago an assistant at the Port Elizabeth Museum was bitten by a Boomslang, which is one of this despised, back-fanged division. The man hovered for many days between life and death, but eventually recovered. I subsequently conducted a long series of experiments with this species of snake, and found that, weight for weight, the venom of the Boomslang was equal in its toxic or poisonous power to that of the Cobra. Other snakes of this back-fanged group were also tested and found to be exceedingly venomous. This is more far-reaching than on first thoughts might be supposed, for the whole tropical and semi-tropical world abounds in snakes belonging to this back-fanged group, which are regarded as venomous only to a slight degree. If several of the South African species have been shewn to be highly venomous, it is reasonable to infer that a considerable number of species in other countries would be equally venomous.

There are two distinct groups of the front-fanged snakes, viz., the adders (Viperidæ) and the cobras (Clapinæ). These snakes all possess a highly virulent poison, secreted by glands which are connected with the hollow or grooved fangs by ducts or channels, through which the venom flows when the glands are constricted by the masseter muscles. The primary action of adder or viper poison is on the blood and the endothelial cells which line the capillary blood vessel walls, causing hæmorrhage into the tissues more or less extensive, according to the quantity of venom injected. Although possessing nerve-poisoning properties, the chief principle of adder venom is a hæmorrhagin or blood poison.

It takes a larger quantity of adder venom to cause death than is the case with the venom of the cobra. The venom of the cobra is a neurotoxin or nerve poison. It poisons the nerve centres controlling the lungs, causing them to collapse. At the same time it paralyzes the inhibitory nerve which regulates the pumping of the heart, and results in a wild and rapid beating of that organ. A singular fact in regard to cobra poisoning is that for fifteen minutes, and even more, after the lungs have collapsed and the victim has ceased to breathe, the heart is still beating.

There are a score or more favourite so-called antidotes for snake venom poisoning, in South Africa. Some of these are proprietary, and others are native remedies. I have been engaged off and on for many years past in experimenting with these alleged antidotes, which the population of this country, both black and white, believe to be sure cures. One of these alleged antidotes is a substance known as Sebiba or Zibiba, which is considered to be an infallible antidote for snake bite by two-thirds, at least, of the native population of South Africa, and by thousands of farmers, who sew it to their braces in order to have it readily available in an emergency. This substance has a remarkable reputation, and it is looked upon as an insult if it is suggested to those who believe in its virtues that it is quite worthless. I procured fresh samples of Sebiba from various parts of South Africa, and conducted a long series of experiments under test conditions with it, but found it to be of absolutely no antidotal value in the treatment of poisoning by snake venom.

It is impossible, in this short address, to go into details in regard to all my experiments and findings with alleged snake venom remedies, and the nature and effects of snake venom, but those who are interested in the subject may read the results of 10 years' experiences and experiments in the revised and enlarged second edition of the work entitled "The Snakes of South Africa, their venom and the treatment of snake bite." This book contains upwards of three hundred illustrations, the great majority of which are original. The volume will be issued in August, 1912.

Permanganate of potash is a chemical antidote to snake venom. If brought into actual contact with the poison it will destroy it, but to be of any service it must be applied within a few minutes of the infliction of the bite. The site of the punctures must be well scarified and the permanganate salt rubbed in freely. The limb must also be ligatured and a doctor summoned at once. In no case should the ligature be allowed to remain on the limb for more than an hour at the very longest, otherwise there is grave danger of the part mortifying. The ligature should be slightly loosened and instantly tightened up again. This may be repeated at intervals of ten minutes until the ligature is discarded. The reason for this is that the poisoned blood is allowed to gain access to the general circulation in small quantities, thus enabling the vital forces of the body the better to cope with and eliminate it.

Permanganate of potash cannot follow up the venom and neutralize it in the blood. Its only beneficial action is the power of destroying what venom still remains in the vicinity of the wounds. Often, in spite of prompt application of the permanganate of potash to the scarified sites of the punctures inflicted by the snake's fangs, sufficient venom is absorbed to cause death, as was the case recently with a well-known young farmer who was bitten on the ankle by a Mamba and died a few hours later, in spite of the punctures being freely scarified and rubbed full of permanganate of potash within three minutes of the infliction of the bite.

The ligaturing and treatment by permanganate of potash must be regarded as a first-aid treatment only. The most efficient after-treatment is the injection of an anti-venomous serum, either sub-cutaneously or direct into the vein. The latter plan is usually adopted in extreme cases where the symptoms are severe and treatment has been unduly delayed.

The serum is prepared by immunizing horses and mules to the mixed venoms of the viperine and colubrine snakes, thus making it polyvalent. It takes at least a year and a half to raise the degree of immunity sufficiently high for the serum to have a fair antidotal strength. This serum, if injected in sufficient quantity, has the power of neutralizing the venom in the blood, and rendering it harmless. The serum treatment of snake venom poisoning is fully dealt with in the volume mentioned, as is also the other forms of secondary treatment. It would therefore be a waste of time for me to enlarge upon it here.

Section D.—ANTHROPOLOGY, ETHNOLOGY, EDUCATION, HISTORY, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY.

President of the Section :—W. A. Way, M.A.

TUESDAY, JULY 2.

The President delivered the following address:

SOME RECENT SOCIAL AND EDUCATIONAL DEVELOPMENTS.

I must, at the outset, express my opinion that the work of this section is more difficult and controversial than the work of other sections, owing to the indeterminate nature of the data. I believe, however, that our knowledge in regard to some of the subjects comprised within this section will not long remain in its present inexact condition.

Is it too wild a dream to see in imagination a state of things in which boys at school may be tested by a simple instrument as to their receptivity and energy and fitness for further work—in which a meeting may be adjourned when certain mechanisms show that the creative brain capacity of the roomful has ceased to be effective—when we may drag from the criminal's eye the visualization of his crime or extract from his brain an automatic confession of his motive and his guilt? I feel certain that we shall be able to find in physical phenomena explanations of conduct and action now hidden from us. It has always amazed me that some deliberators, for example, individually men of personal charm and unquestioned ability, should collectively and *en masse* do such, shall I say, eminently unsatisfactory things. I feel sure there is some combination of magnetic phenomena, some uncoefficient, as it were, of friction which would explain sometimes almost inexplicable resolutions. We know that over great meetings waves of some kind of feeling pass with wonderful results. There may be some in this room who remember at a Diocesan Synod at Grahamstown a wave of emotion, which one clerk described to me as the clearest manifestation of a Holy Spirit he could imagine. We know that panic and grief, humour and indignation are supremely infectious, and spread in currents through vast throngs of people. Here we shall have to call in, I think, workers in other departments of knowledge, although it is depressing to think that religious exaltation may be reduced to a chemical formula or appreciation of art to a physical equation.

With the need, then, before us of a deep scientific analysis of emotion, of the very hardest and closest thinking and reasoning, it is somewhat perplexing and disappointing to find that the modern tendency of education is to emasculate the intellect of the pupil. Just as no child, although its life may be saved, can thrive and grow if it is always given predigested food, so no pupil's intellect can grow and expand if its lessons are daily served up to it in a predigested state. The modern teacher must make every crooked path straight before he sends his pupil down the road to knowledge. In modern text-books every difficulty is anticipated and made smooth—the accursed note follows each word and line—the pupil has always one eye on the text and the other on the notes, and his mental attitude corresponds; he ceases to search for answers himself—he is spoon-fed with solutions of anticipated perplexities. The dramatisation of history, a new craze, procures for him in a mixed school an acted scene of Sir Walter Raleigh laying his cloak in the mud before Queen Elizabeth, and in a boys' school Charles I. dies like a gentleman on the scaffold, or a scowling John signs the Magna Charta surrounded by truculent nobles whose ages vary from 8 to 13. The bioscope presents to him a vivid picture of scenes and industries, leaving nothing to his unexercised and atrophied imagination; and the combination of kinematograph and phonograph will soon give Irish schools a speaking and sounding picture of Mr. Redmond supporting the Home Rule Bill in the House (all complete with Sir E. Carson's fierce interruptions), and Church schools will show their pupils with melancholy resignation Mr. Lloyd George or Mr. McKenna introducing the Bill for Welsh Disestablishment.

The present devotion of the younger generation to sport is a natural consequence of this training in the concrete and the actual, although there is, I think, another cause which I hope to touch upon presently. There is very little left to the imagination in sport. The results are very visible and tangible. A decision, in fact, is the outcome of all sport. Either one side beats the other, or by a settled system of scoring the two opponents are declared equal. This definiteness appeals to the average mind, and the result of a cricket match between Australia and England is awaited with far more eagerness than the phases of an important Parliamentary debate, the investigations of some scientific commission or the publication of some literary masterpiece. So the reaching of the North or South Pole is a definite achievement, and arouses the sporting curiosity of millions who are indifferent to the general scientific discoveries of either the successful or the unsuccessful expedition.

This devotion to outdoor sports and games requires, I think, the very careful consideration of all those interested in the development of social instincts. As a schoolmaster, I should like to bear testimony to its excellent results in many problems of boy-life and development, and also, as a schoolmaster, to its often deleterious effect upon actual school work. There is, however, a deeper-seated reason than the one I have mentioned. This, I venture to say, is the instinct inherited from our ancestors, an instinct which shows itself more prominently in new and undeveloped countries where out-of-door habits and comparatively uncivilised life-conditions tend to reproduce the life habits of our ancestors of plain and forest. War, in defence of life and territory and property, the chase in search of food—these were the all-pervading conditions of early human life. Now sport is mimic warfare, and skill in games corresponds to that skill in the chase, the possession of which gave the strongest and most dexterous the best and most plentiful sustenance, and the absence of which led to degeneracy and decay and extinction.

To this revival of early instinct I attribute the almost universal desire of South Africans to go farming. The doctor, the professor, the man of business, the lawyer, all seem to have an expressed or unexpressed desire to end their lives on a farm. It is the instinctive hunger of the early man in each to see his crops growing and his beasts increasing in number, to gaze out over land which is his own, and to live untrammelled by the close proximity of his neighbours and possible enemies.

I have mentioned the craving for definite results as caused by the modern tendency of education in the concrete. The examination craze follows as a natural event. There must be a definite cut-and-dried result to this cut-and-dried education, and a student's whole career and life-history is to have set upon it the seal of approbation or of damnation by the amount he can reproduce in eighteen or twenty hours in answer to arbitrary questions sent to him by people who have never seen or heard of him. These results are published broadcast and eagerly devoured by the public, and success falls perhaps to some youth of natural ability, who has been lazy, careless, and even vicious, while failure brings disgrace to one who is unmeasurably superior in all the qualities of manhood.

If only all school examinations in this country could be abolished for five years! I know that there are vested interests at stake, that certain teachers and professors earning their modest incompetences would severely feel the loss of an annual remuneration and a fixed method of passing their vacations; but I think that parents and pupils would subscribe the amount in a month, and teachers would certainly subscribe it in a week. In any case the University authorities should be legally restrained from taking up a page and a half of the *Cape Times* or other papers with the long lists of results.

Some teachers I know would feel the loss of an annual stimulus, the pitting of their wits against the often unreasonable ingenuity of examiners. But I think this is a poor and unnatural stimulus to the work of education, and it is time that high schools ceased to be looked upon as so many racing stables, classified according to the number of their passes, as in the lists of successful jockeys which we read of in sporting newspapers.

The Report of the Consultative Committee on Examinations in Secondary Schools is an epoch-making document. Let us hope that its recommendations will be adopted in this country, and that a boy's school career will be gauged in future by intelligent tests as well as by his reports all through his school career.

If these reforms are carried out, a pupil will be examined once at the age of 15 or 16, and once at the age of 17 or 18. Teachers will be asked to suggest questions and limits for examination—but not, I hope, to set the actual questions. A Board of Examiners for each District, aided by a District Inspector of high academic qualifications, who knows the schools of his district intimately, and has helped with advice and sympathy in their development, will set examination tests. Attached to each candidate's name will be his school record, his achievement in this or that branch of school life, his various masters' opinions of his intellect and moral qualities—also, if need be, a list in order of merit of the various candidates, as a check upon a chance examination result. A general certificate will be awarded, after a short interview and a talk with each candidate, and distinction in any subject can be notified on the certificate. The Inspector must see that this examination is taken, as it were, in the stride of the school, and must sternly discourage all attempts at cramming and extra coaching, which might impair health or intellect. The scheme seems so reasonable and so feasible that surely the Education Department and the University could arrange the details before the end of 1913.

As a natural consequence, also, the legislative assemblies of the country become too stolid and practical. No Addisons, or Morleys, or Bryces could rise in South Africa to high positions in the State—the position of the savant in France and Germany is not reproduced in this country. So Fencing Bills and Estate Duty Acts go through the House with ease, but a Minister of Education with half a million in his hand is not able to found a National University as a brain centre to the land, and one of its sole hopes of future salvation.

Another disturbing feature of modern education is the desire among politicians, and also, I regret to say, among many parents to throw upon the schools the entire responsibility of the younger generation. Although most pupils attend school for only five or six hours out of the twenty-four, the school is gradually being made responsible for every phase of their moral, intellectual, and physical well-being. I will grant that character must be trained that intellect must be stimulated, that physical culture must be taught in those five or six hours, but the school is now expected to take from the hands of parents and others responsible, phases of development which do not rightly belong to the school. In some of the elementary schools in England, children are being fed in class; there is a strong movement in favour of the medical inspection of school children and its logical outcome, the establishment of school clinics where pupils are treated for ailments and diseases. Worse still, children are taught in school at early ages the beginning of those trades and crafts in which they are to seek their living afterwards. The demand is that the schools shall send out half-trained farmers, teachers, carpenters, book-keepers and clerks. Every association with a cause at heart wishes to introduce him to its text-book; and Readers in Temperance, Readers in Hygiene, Readers in Moral Conduct are forced upon his bewildered attention. The student, while still under the care of his master, is to be trained in arms to defend his country. Between the ages of 8 and 11 he is crammed with a reading-book on Civic Duties, and learns Moral Philosophy by standards: Truthfulness in Standard I, Courage in Standard II Patriotism in Standard III, Perseverance in Standard IV, and so on.

Girls, who used to be taught household duties under the loving care and supervision of their parents, are now compelled to spend unreasonably long periods at school over sewing and cookery and domestic science. They are taught by their mistresses, instead of by their mothers and elder sisters, how to dance and behave themselves in public, and to entertain friends and guests. In some schools the function of the police court is usurped, and juvenile mockeries of tribunals dispense amateur justice for offences committed outside, and as well inside, the school premises.

And now the clergy, at their own request in most cases, are to be deprived of what one would have imagined they considered their special and most precious work, namely, the definite religious teaching of the young. In fact, the school seems destined to lessen or to obviate entirely the work and duty of the parent, the employer, the magistrate, and the clergy.

From the age of 3, when children are taken off their parents' hands to dally through Kindergarten exercises, the school is responsible for almost every phase of the development of the younger generation. The school, in fact, has to do everything with the child except bring it into the world, and if the State is going to undertake so much responsibility I do not see how it can fail eventually to propose some State system of eugenics which will make marriage a matter of State permission, or even selection. It is the consideration of logical extremes of this kind, against which all reasonable human beings must revolt, which sternly calls for some halt to be made in this surrender to the school of so many grave responsibilities which really belong to others.

If people complain to-day of the want of that old-time reverence and respect towards parents and elders, may we not justly attribute the fault to those parents who shirk the responsibility of training their children themselves, and hand them over entirely to the management of the State and its servants?

In conclusion, I must give feeling to a very great disappointment and regret. The country has been through a time of great trial and trouble, and a new nation is supposed to have emerged shining and triumphant from the ordeal. In all history such a nation-birth has ever been signalised by a great outburst of literary and intellectual activity. Here in South Africa we look for it in vain. This fact I attribute partly to the gross materialism which is affecting South Africa no less than other countries, to the desire to get rich first and become great afterwards, and partly to the deplorable quarrel over languages.

There are problems of wonderful moment and of almost horrible fascination before this century. Man, as a recent writer has said, is always grasping in his hands more than he can imagine in his mind. The greatest discoveries are too wonderful even for the imagination to foretell. The prolongation of living, either by increasing through curative medicine the average age-limit of man or by a system of sterilised rest and abeyance of the still living organism for long periods of quiescence; the predetermination of sex; the conquest of the air, not by machines, but by flying human beings; the victory over mental and physical disease; the production of an increasing food supply; the discovery and necessary limiting of almost omnipotent engines or methods of destroying life; the destruction of property; the political and social status of black or Coloured citizens; the State elimination of all immoral tendency—these are some of the problems before the thinkers and writers of to-day.

In the solution of these world problems we in South Africa must take our share, not necessarily as brilliant discoverers, but by patient research each in his own sphere. Our President (Dr. Theiler), by his brilliant researches into animal infection, has shown what can be done in the way of combating disease. In mining engineering I do not think that our Johannesburg members will be surpassed as regards daring, skill and economy by any engineers in the world.

But are all those other problems so easy of solution in one language that we must fetter ourselves with more than one? Is it so easy for a nation to be great in one tongue that our misguided, if earnest-minded, politicians are asking us to be great in two?

LIST OF PAPERS READ AT THE SECTIONAL MEETINGS.

Section A.—Astronomy, Mathematics, Physics, Meteorology, Geodesy, Surveying, Engineering, Architecture and Irrigation.

WEDNESDAY, JULY 3.

1. Address by H. J. Holder, M.I.E.E., President of the Section.
2. Some practical details of Kater's pendulum. By Prof. R. A. Lehfeldt, B.A., D.Sc.
3. The Minor planet MT 1911, and minor planets in general. By R. T. A. Innes, F.R.A.S., F.R.S.E.

FRIDAY, JULY 5.

4. South African Meteorology: Weather forecasting. By A. G. Howard, F.S.A.

Section B.—Chemistry, Geology, Mineralogy, and Geography.

TUESDAY, JULY 2.

1. Address by Prof. B. de St. J. van der Riet, M.A., Ph.D., President of the Section.
2. Note on the Thaba Bosigo sand-dunes. By Prof. G. H. Stanley, A.R.S.M., M.I.M.E., M.I.M.M., F.I.C.
3. On veins and inclusions in the Stellenbosch granite. By Prof. S. J. Shand, Ph.D., D.Sc., F.G.S.

WEDNESDAY, JULY 3

4. Some notes concerning a deep bore at Zwartkops, near Port Elizabeth, and the resulting thermal chalybeate spring. By G. W. Smith, A.M.I.C.E.
5. The saltpans of the coast region. By W. S. Stead.
6. Laccolites and Bysmalites. By Prof. E. H. L. Schwarz, A.R.C.S., F.G.S.
7. The formation of chemical compounds in homogeneous liquid systems: a contribution to the theory of concentrated solutions. By Prof. R. B. Denison, M.A., D.Sc., Ph. D.

FRIDAY, JULY 5.

8. The serum or precipitin test for blood, and its practical application in medico-legal cases in the Cape Province. By J. Muller, B.A., F.C.S.
9. The sugar content of maize stalks. By G. N. Blackshaw, B.Sc., F.C.S.
10. The use of wood ashes for manurial purposes. By A. Stead, B.Sc., F.C.S.
11. Is silica an indispensable constituent of plant food? By M. Lundie.
12. Electrolysis of water with carbon electrodes. By E. G. Bryant, B.A., B.Sc.

Section C.—Bacteriology, Botany, Zoology, Agriculture Forestry, Physiology, Hygiene, and Sanitary Science.

TUESDAY, JULY 2.

1. Address by F. W. FitzSimons, F.Z.S., F.R.M.S., President of the Section.

2. Some antarctic fresh water annulates. By Prof. E. J. GODDARD, B.A., D.Sc., and D. E. MALAN, M.A.
3. Some observations on *Convoluta roscoffensis*. By H. A. WAGER, A.R.C.S.
4. Floral persistence under special circumstances. By Rev. F. C. KOLBE, B.A., D.D.
5. Poisonous properties of *Mesembrianthemum Mahoni* N.E.Br. By J. BURTT-DAVY, F.L.S., F.R.G.S.

WEDNESDAY, JULY 3.

6. Farming by dynamite. By W. CULLEN, M.I.M.M.
7. Preliminary list of flowering plants, ferns, and fern allies found in the Port Elizabeth District. By I. L. DREGE.
8. On the effects of the bite of certain ophisthoglyphous snakes. By W. H. ANDREWS, M.R.C.V.S.
9. Line breeding, as applied to sheep. By C. MALLINSON.
10. Methods of sero-diagnosis applicable to diseases of stock in South Africa. By D. KEHOE, M.R.C.V.S.
11. Cape wine levures and their use in wine-making: a preliminary study. By A. I. PEROLD, B.A., Ph.D.
12. Additions and corrections to the recorded flora of the Transvaal and Swaziland. By J. BURTT-DAVY, F.L.S., F.R.G.S.
13. Stomata and drought resistance in mealies. By H. A. WAGER, A.R.C.S.
14. The human digestive organs. By F. W. FITZSIMONS, F.RS., F.R.M.S.

FRIDAY, JULY 5.

15. The indigenous high forest of George, Knysna and Humansdorp. By J. S. HENKEL.

SECTION D.—ANTHROPOLOGY, ETHNOLOGY, EDUCATION, HISTORY, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY, AND STATISTICS.

TUESDAY, JULY 2.

1. Address by W. A. WAY, M.A., President of the Section.
2. South Africa and the undergraduate. By A. E. GRIFFITHS, B.A.
3. The study of French in foreign universities. By Prof. R. D. NAUTA.

WEDNESDAY, JULY 3.

4. Bergson's conception of Time. By Rev. S. R. WELCH, B.A., Ph.D., D.D.
5. The South African Public Debt. By Prof. R. A. LEHFELDT, B.A., D.Sc.
6. Bartholomeu Diaz' furthest east. By Prof. E. H. L. SCHWARZ, A.R.C.S., F.G.S.
7. The limits of science in the material universe. By O. MIDDLETON, A.R.I.B.A.
8. Agricultural statistics. By G. F. JOUBERT.
9. The Universal Races Congress. By JULIA F. SOLLY.
10. A comparison of municipal elections under the present system and under the transferable vote. By J. BROWN, M.D., C.M., F.R.C.S., L.R.C.S.E.
11. The tradition of Ra'lolo. By Rev. J. A. WINTER.
12. The history of Sekwati. By Rev. J. A. WINTER.
13. Hymns in praise of famous chiefs. By Rev. J. A. WINTER.

THE SUGAR CONTENT OF MAIZE STALKS.

By George Neville Blackshaw, B.Sc., F.C.S.

In recent years much attention has been directed to the discovery of economic uses to which the maize plant may be put, other than those for which the crop is now cultivated. At the present day maize is grown more particularly for use as cattle food in the green state and in the form of ensilage, and for the production of grain which is chiefly employed as a feed for live stock, for the manufacture of commercial glucose and alcohol, and for human consumption in the shape of meal and refined products.

The institution of new markets for what is regarded as one of our staple products is surely a matter of vast importance to this country, and endeavours to extend the commercial possibilities of this great cereal will in time, it is hoped, be brought to a successful issue.

In a short paper dealing with the sugar content of maize stalks, which I contributed at the meeting of this Association in Bulawayo last year,* it was pointed out that the idea of manufacturing sugar from the juice of maize stalks was by no means new; that, in fact, a factory was established in France about the year 1850 where large quantities of sugar were manufactured from this source, but that the project proved unsuccessful owing to the development of the beet sugar industry.

In the year 1881, Collier, who was then acting as Chemist to the United States Department of Agriculture, in a series of

* Rept. S.A. Assoc. for Adv. of Sc., Bulawayo, 1912, pp. 269-273.

carefully conducted experiments on several varieties of maize obtained the following results for maize stalk juice, in which the specific gravity exceeded 1.055:—

	Per cent.
Juice obtained	54.60
Sucrose in juice	11.72
Glucose	2.27
Solids not sugar	2.39

Number of analyses—28.

Collier, in reporting upon his extensive investigations in this connection, drew attention to the erroneous idea, prevalent at the time, that the stalks of maize are dry and useless when the grain is ripe, and went on, further, to say that it seemed possible that the judicious use of the stalk would add greatly to the profit of the industry.

During the period in which Collier was conducting his experiments, the subject was being independently investigated in Pennsylvania by Mr. F. L. Stewart, who, as I pointed out in the previous paper on this subject, found that if the cobs were removed whilst immature, the amount of sucrose in the juice increases, and also that stalks from which they have been removed remain green and vigorous for a longer period than the stalks bearing ripe corn.

Stewart has been working upon the subject for a number of years, and some time ago advanced the opinion that the maize plant could be economically used for the production of sugar, cellulose and alcohol simultaneously, the process being characterised by the complete utilisation of the plant, stalk, leaf and cob. Although figures are quoted which show that the profit when the maize plant is so used far exceeds that at present obtained, Mr. Stewart states that the crop has not hitherto been utilised on a large scale for this purpose, for the reason that until recently his work in developing the different branches was not entirely completed.

With a view to determining the sugar content in the juice of stalks of Rhodesian grown maize, an experiment was conducted on a small scale last year, the results of which were given in my previous paper. As pointed out at the time, the crop was very unsatisfactory for the purpose of the investigation owing to the lateness of planting and the heavy infestation of stalk-borers. The results were, however, interesting in that they afforded data in regard to the sugar content of stalks so infested.

During the season just completed, a more extensive series of experiments has been made for the purpose of investigating the sugar content of stalks of five varieties of maize, four of which are commonly grown in this country. The five varieties under trial were Hickory King, Salisbury White, Boone County, Golden Eagle, and Sweet Corn.

The ground used for the experiment—a heavy red loam—was well prepared, and kept in good tilth throughout the season. The maize was sown on November 9th, and all varieties making very good growth and being entirely free from insect attack the plants were in every way suitable for the purpose of the investigation. From a portion of each plot, the cobs were removed in a milky condition on April 2nd, and the juice of stalks selected from the cobbed and uncobbed portions analysed periodically until the crop reached maturity.

Methods of Analysis Employed.

One or more stalks of the variety to be examined were selected in the plot, and the juice thereof submitted to analysis on the same day. The "stripped stalk" was weighed, cut into strips not more than half an inch in thickness, and the juice expressed under gradually increased pressure between the steel rollers of an ordinary flattening mill; the juice collected weighed and strained through a fine linen cloth. The *specific gravity* was determined with a "specific gravity bottle." For the determination of *total solids* in the strained juice, 5 c.c. were introduced into a 2½ inch aluminium basin, the bottom of which was previously covered with coarse sand to insure complete desiccation, evaporated to dryness on a water-bath, and kept at a temperature of 95°C. until the weight became constant. For the determination of *sucrose* and *glucose*, 100 c.c. of the juice were taken and defeated with basic lead acetate and alumina cream. In the filtrate from the lead precipitate, which was perfectly clear, the sucrose was determined by the polariscope

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* In order to determine if any optically active constituent other than sucrose was present in *normal juice,* several determinations of the sucrose by cuprous precipitation before and after inversion as well as direct polarisation were made; in every case the amount shown by the different methods agreed very closely, indicating that sucrose was the only optically active substance present.

method.* For the determination of glucose, 60 c.c. of Fehling's solution were introduced into a 200 c.c. beaker, diluted to 100 c.c. with boiling water, and heated to boiling by being placed in a vessel containing boiling water. 5 c.c. of the clear filtrate from the lead precipitate were then added, and the water in the outer vessel boiled for a quarter of an hour After decanting off the excess of Fehling's solution, the precipitated cuprous oxide was washed with well-boiled boiling water in a tared Gooch crucible, and the crucible dried, strongly ignited and weighed. The weight of cupric oxide thus found, multiplied by .4535, gives the weight of glucose in the amount of clarified juice used.

The results obtained with the five varieties of maize were as follows:—

"A." COMPOSITION OF THE JUICE OF STALKS FROM WHICH THE COBS WERE REMOVED WHEN IN THE MILKY CONDITION.

Cobs Removed April 2nd, 1912.

Variety.	Date Collected	Number of Days after the Removal of Cobs.	Juice %	Specific Gravity.	Total Solids. %	Sucrose. %	Glucose %	Solids not Sugar. %
Hickory King ..	April 11	9	55·6	1·064	15·60	11 27	2·39	1·94
	do. 16	14	45·2	1·072	17·25	13 20	2·11	1·94
	do. 24	22	50·6	1·066	16·04	12·52	1·55	1 97
	May 9	37	44·0	1·073	17·67	13·97	0·96	2·74
	do. 15	43	48·9	1·065	15·90	11·28	1·49	3·13
Boone County ..	April 10	8	51·6	1·058	14·17	10·57	1·70	1·90
	do. 15	13	47·6	1 065	16·15	11·43	2·94	1 78
	do. 23	21	40·5	1·064	15·13	11·24	1·80	2·09
	May 8	36	51·9	1·072	17·70	13·62	1·06	3·02
Salisbury White	April 12	10	39·7	1·071	16·80	12·96	1·58	2·26
	do. 16	14	40·3	1·069	16·91	12·79	1·40	2·72
	do 26	24	42·9	1·069	16·98	12·91	0·85	3·22
	May 10	38	45·6	1·069	16·87	12·75	0·90	3 22
	do. 17	45	52·3	1·059	14·56	10·24	2·20	2·12
	do 23	51	42·7	1 067	16·40	12 07	1·01	3·32
Golden Eagle ..	April 12	10	40 9	1 062	15·53	11·22	1·96	2·35
	do. 18	16	47·4	1 063	15 46	11·08	2·06	2·32
	May 2	30	48·2	1·063	15·63	11·27	1·37	2·99
	do. 3	31	46·3	1·066	15·91	12 61	1·09	2·21
	do. 13	41	40·5	1·059	14·69	9 77	2·20	2·72
	do. 22	50	43·0	1 069	16·95	11·82	1·41	3·72
Sweet Corn ..	April 10	8	47·1	1·052	12·94	8·73	2·46	1·75
	do. 15	13	48·5	1·054	15·00	9 42	1·75	3·83
	do. 22	20	44·1	1·057	13 96	9·84	1·86	2·26
	May 7	35	51·0	1·069	16 87	12·69	1·10	3·08

"B." Composition of the Juice of Stalks on which the Cobs were allowed to Mature.

Variety.	Date Collected.		Juice. %	Specific Gravity.	Total Solids. %	Sucrose. %	Glucose. %	Solids not Sugar. %
Hickory King ..	April	3	45 7	1·052	13·59	9 60	2·53	1·46
	do.	4	43·8	1·054	13·43	9·58	1 90	1·95
	do.	24	45·0	1·067	16·77	11·67	1·50	3 60
	May	9	44·3	1·059	14·39	10·94	0·72	2·73
	do	15	41·2	1·056	14·14	10·30	0·81	3·03
	do.	20	48·4	1·046	11 47	8·08	2·20	1·19
Boone County ..	April	2	52·4	1·043	10·70	6·83	2·30	1·57
	do.	23	53·9	1 055	13·45	10·29	1·80	1·36
	May	8	49·9	1·028	6 90	3·33	2·35	1·22
Salisbury White	April	9	43·7	1·056	14·11	10·49	1·72	1·90
	do.	26	45·1	1·047	11·80	8·78	1·46	1·56
	May	10	42 4	1·038	9·30	6·82	0·55	1·93
	do	17	50·7	1 066	16 26	12·69	0·71	2·86
	do.	23	44·9	1 050	12·00	8·67	1·19	2·14
Golden Eagle ..	April	9	50·5	1·041	10·15	6·15	3·05	0 95
	May	2	37·6	1·023	5·41	2·20	2·17	1·04
	do.	3	44·5	1·030	7·72	4·34	1·86	1·52
	do.	13	38·4	1·025	6·47	2·82	1·38	2·27
Sweet Corn ..	April	2	46·9	1 050	13·73	8·49	2·69	2·55
	do.	22	43·9	1 053	12·99	9 67	1·34	1·98
	May	7	52·8	1·014	10 80	7 47	0·71	2·62

It is to be noted that:—

(1) In the uncobbed plants examined the percentage amount of sucrose in the juice varied to a very great extent as the crop approached maturity.

(2) That the sucrose content of the juice was much more uniform in the cobbed plants.

(3) That the average amount of sucrose in the juice of stalks bearing cobs examined between April 2nd and 9th (excluding sweet corn) was 8.2 per cent., and the average amount in the juice of plants of the same varieties cobbed on April 2nd and examined between April 10th and 12th was 11.5 per cent., and that therefore in those plants from which the cobs had been removed the amount of sucrose increased considerably during the first eight or ten days after cobbing.

(4) That the sweet corn variety gave the lowest results per acre for sucrose.

(5) That in all cobbed plants examined between April 10th and May 23rd (eight to fifty-one days after removal of cobs), sweet corn excluded, the average sucrose content of the juice was 12 per cent.

In regard to the percentage amount of total solids recorded in the juice, it should be pointed out that a small amount of suspended matter was present, and that in consequence the "solids-not-sugar" percentage does not entirely consist of material in solution other than sucrose and glucose. It is to be noticed, however, that a close relationship exists between the specific gravity of the juice and the amount of total solids and sucrose present, indicating that the little suspended matter present in the samples examined was very uniform in quantity.

In order to obtain an estimate of the amount of sucrose contained in the juice of stalks of four varieties of maize grown locally per acre, treated as Mr. Stewart directs, the following computation has been made from the data collected in this investigation.

Estimate of the Amount of Sucrose contained in the Juice of Four Locally Grown Varieties of Maize (Hickory King, Salisbury White, Boone County, and Golden Eagle), treated according to Stewart's Process (per Acre).

No. of Stalks Analysed (4 Varieties)	Total Weight of Stalks lbs	Average Weight of Stalks. lbs.	Total Weight of Juice Expressed from 22 Stalks. lbs.	Average percentage of Juice Expressed per Stalk.
22	27·81	1·26	12·6	45·6

Sucrose in Stalks per Acre.—Assuming that the average sucrose content of the juice is 12 per cent., and, taking the number of stalks per acre at 8,500, the amount of sucrose in the stalks per acre would be 585 lbs.

Glucose in Stalks per Acre.—Assuming that the average glucose content of the juice is 1.65 per cent., the amount of glucose in stalks per acre would be 80 lbs.

(8,500 plants per acre is a very liberal estimate in Rhodesia, where the crop is grown for grain production, but should the crop be grown for the production of sugar, cellulose and alcohol, thicker planting would very likely be possible.)

Comparison of the Results obtained in Season 1910-11, and 1911-12.

In the few tests made in the season 1910-11 it was observed, firstly, that in no instance did a marked increase in the amount of sucrose present in the juice manifest itself as the length of time after the removal of the cob advanced, and secondly, that no marked difference between the sugar content of cobbed and uncobbed plants was noticeable. As reported at the time, the condition of the crop was unsatisfactory, owing to lateness of planting and insect attack, and consequently the results might have been influenced thereby. That such was the case seems certain from the results obtained during the season 1911-12, since the average sugar content of the cobbed plants examined this year, which were in all cases well-grown and healthy, was much higher than in those plants on which the grain was allowed to mature. Whilst on this point I might say that there is reason to believe that the sucrose content of the juice obtained from the top and bottom portions of the stalk are not the same, and that the juice of the top half contains a higher percentage amount of sucrose than the bottom half. In other words, that the sucrose content of the juice is not uniform from the bottom to the top of the stalk. With a view to ascertaining if such was the case, *mature* stalks from which the cobs had been removed in the milky stage were roughly cut in half transversely, and the juice expressed from the top and bottom portions examined. In the three tests made, the difference between the sucrose content of the two portions varied from 2 to 4 per cent. in favour of the top half, although the perecentage amount of juice expressed therefrom was much lower. This being the case the results obtained last year are only to be regarded as applicable to maize infested with stalk-borer.

In conclusion, I would point out that, so far as I am aware, it is not Mr. Stewart's contention that the maize plant can be utilised more profitably for the production of cane sugar *only*, but that the three products—cane sugar, cellulose and alcohol—are producible simultaneously from the respective parts of the plant at a very much lower cost than from any other known source. Whether this statement applies in South Africa has still to be determined, and it was with a view to acquiring data upon the "sugar phase" of the question that this investigation was undertaken. That paper of good quality can be manufactured from maize stalks has long been recognised.

Flowering Plants of the Transvaal and Swaziland.—A check list of Transvaal plants, probably the first of its kind, has recently been published by Mr. J. Burtt Davy and Mrs. R. Pott-Leendertz. It comprises 157 families, 919 genera, and 3,264 species. Mr. Burtt Davy defends the publication of a preliminary check list, in advance of a more accurate catalogue, not alone because of the delay inherent in the preparation of the latter, but also on ground of its value to the working biologist, its assistance in delimiting geographical distribution of species, and its worth in stimulating the search for additional species by amateurs and nature lovers, and so hastening the completion of a full catalogue, and finally of a flora.

NOTE ON THE THABA BOSIGO SAND-DUNES.

By Prof. George Hardy Stanley, A.R.S.M., M.I.M.E., M.I.M.M., F.I.C.

(Plate 2.)

During the visit of the Association to Thaba Bosigo, Basutoland, in 1909, the sand-dunes were not the least interesting of the natural features inspected, and considerable speculation was indulged in regarding their origin.

The writer brought back a sample for microscopic examination, and found that it exhibited the usual characteristics of wind-blown sand, as will be evident from an inspection of Fig. 1, the particles being of approximately uniform size, and well polished and rounded.

Fig. 1.

The origin of the sand, however, is not at first apparent, but from a consideration of the local features it would appear to be a result of wind action, more or less as detailed in the following statement.

The mountain itself is of the flat-topped type so common in the country, the top consisting of a stratum of sandstone which forms an undulating plateau covered to a large extent with grass.

At the sides this top stratum forms nearly vertical cliffs as shown in the upper photograph, Plate 2, the slope commencing and running down from the bottom of this, and being strewn with loose blocks of sandstone.

The sandstone consists of layers of variable thickness which have weathered to different figures, as seen clearly in the middle photograph, Plate 2, the removal of the softer bands leaving overhanging shelves of harder rock, and in some cases forming caves.

The agent which has brought about the removal is, in the writer's opinion, chiefly the wind, since rain or running water has no access, at any rate immediately under the overhanging slabs.

The wind, charged with sand, would also act in the same way as a sand blast, causing further abrasion of the rock surface.

This sand-laden wind, then, rising above the top of the plateau, forms eddies and drops at least some of the sand, which has accumulated and formed dunes in suitable spots.

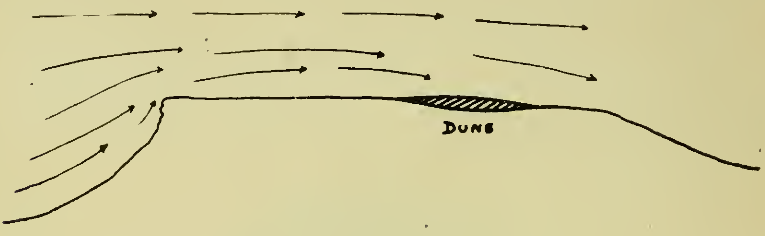


Fig. 2.

Figure 2 illustrates what is assumed to occur, and the lowest photograph, Plate 2, shows the end of a dune in the position shown in Fig. 2.

In high winds sand will undoubtedly be blown off the dunes and off the mountain also, thus diminishing their size, while at other times the wind velocity will be such that sand accumulates and their size increases. Further, with a change of direction, their position tends to alter, and this, of course, is known to take place.

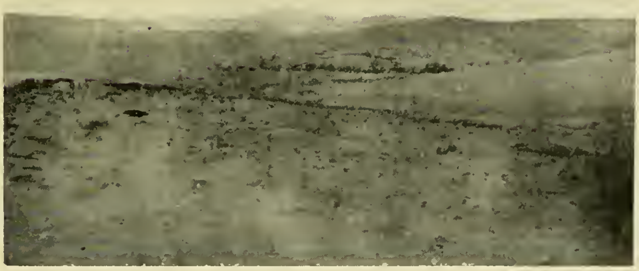
That their size and position can vary with great rapidity under no other action than that of the wind is borne out by the writer's knowledge of the behaviour of sand residue dumps on the Witwatersrand, which afford an excellent example of the transporting power of wind.

The top surface is frequently loose to a depth of a couple of feet or so, and this appears to move from side to side of the dump according to the direction of the wind, that side on which the wind is blowing being often quite bare and relatively hard* through the loose sand shifting over to the lee side.

In one instance in a single night nearly three feet of sand has been blown over on to a place on the lee side, a newly-erected water tank affording means of measurement, and a few hours' high wind in a fresh direction is sufficient to cover with loose sand a previously bare surface.

The sand moves along partly in a series of shifting ripples, and partly in actual suspension in the air, the latter being only too obvious to anyone working on the dump, but the former

* The sand particles are in these cases loosely cemented together by slime and salts formed by oxidation of pyrites.



Prof. G. H. STANLEY, Note on the Thaba Bosigo Sand-dunes

illustrates on a small scale what takes place on the dump, or dune, on a large scale.

If Fig. 3 represents a cross section of a ripple with the wind in the direction indicated by the arrow, the particles of sand lying on the surface *ab* are rolled or lifted along by the wind and over the summit down the slope *bc*, so that the section of the ripple becomes *a'b'c'*, then *a''b''c''*, and so on.

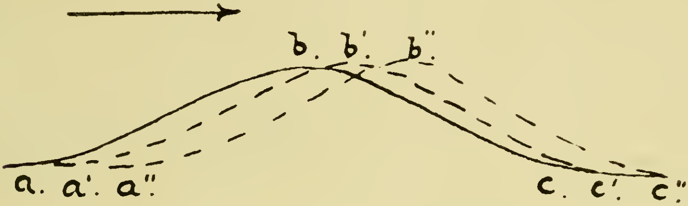


Fig. 3.

Thus the occurrence and varying size, position and form of the sand-dunes appears to be quite simply accounted for, and the dunes furnish ocular evidence of the part played by wind in altering the contour of the earth's surface.

TRANSACTIONS OF SOCIETIES.

ROYAL SOCIETY OF SOUTH AFRICA.—Wednesday, June 19th: Dr. L. Péringuey, F.E.S., F.Z.S., President, in the chair.—"The rainfall on Table Mountain for thirty years": T. **Stewart.** Rainfall observation on Table Mountain was begun in January, 1881, with two stations, one at Disa Head and one at Waai Kopje. In 1884, two more, at Kasteel Poort and St. Michael's were added. In 1892 seven additional stations were selected. The average yearly rainfall during 27 years was as follows: 61.74 inches at Kasteel Poort, 2,483 feet above sea-level; 75.24 inches at St. Michael's, 3,050 feet above sea-level; and 67.63 inches at Waai Kopje, 3,100 feet above sea-level. The summit of the mountain (Maclear's Beacon) is its wettest place; the rainfall at the gauge there gave 73.34 inches during the driest year (1896), and 126.18 inches during the wettest year (1902).—"On tidal phenomena in wells near Cradock": Prof. A. **Young.** The depth of the deepest well is 225 feet. Thermal waters, containing sulphuretted hydrogen issue, accompanied by large quantities of methane. Measurements of the pressure at which the water issues show a fluctuation analogous to the tidal fluctuations of the sea. Components having the following wave periods were isolated: (1) 12 hrs. 25 mins., (2) 12 hrs. 0 mins., (3) 23 hrs. 57 mins., (4) an unharmonic residuum, which proved to be the vertical inversion of the barograph curve. The author concludes, therefore, that these fluctuations are to be attributed, directly or indirectly, to astronomical causes. The wells are more than 100 miles from the coast, and over 2,700 feet above sea-level.

Wednesday, July 17th: Dr. L. Péringuey, F.E.S., F.Z.S., President, in the chair.—"Addendum to revised list of the flora of Natal": J. M. **Wood.** —"Descriptions of some new batrachia and lacertilia from South Africa": J. **Hewitt** and P. A. **Methuen.** The following were described: *Natalobatrachus bonebergi*, new genus and species; *Bufo Fenhouleti*, new species; *Tetradactylus eastwoodæ*, new species; and *Zonurus Cœruleopunctatus*, new species.—"Notes on Namaqualand Bushmen": Miss L. **Currle.** An account of the characteristics of Cape Colony Bushmen, including descriptions of their mode of life, their food, their dwelling-places, their use of snake, spider and plant poisons for their arrows, their practice of witchcraft, and their views regarding resurrection and transmigration.—"Note concerning the physical significance of the mean diurnal curve of temperature": Dr. J. R. **Sutton.** The author discussed the question whether hourly average temperatures have any great scientific value, and concluded that, at Kimberley, the mean diurnal curve of temperature is possibly made up of three superimposed curves of the same period, proper to various outstanding types of weather.—"Note on the earthquakes of the South African table-land": Dr. J. R. **Sutton.** In connection with the occurrence of four earthquake shocks felt since the establishment of the observatory at Kenilworth (Kimberley), the author calls attention to fluctuations of barometric pressure in progress at the time of the shocks.

South African Society of Civil Engineers.—Wednesday, July 10th: Mr. A. D. Tudhope, M.I.C.E., President, in the chair.—"Watershed statistics of the Wemmers Valley": R. W. **Menmuir.** The available yield of the watershed was calculated at 53 million gallons per day. The rainfall in the catchment area was estimated to have been, in 1904, 85 million gallons per day, in 1905, 69 millions, in 1906, 52 millions, in 1907, 66 millions, and in 1908, 59 millions.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, April 20th: Mr. W. R. Dowling, M.I.M.M., Vice-President, in the chair.—"The action of mineral sulphates and arsenates on cyanide solutions": A. F. **Crosse.** As the sulphates of magnesia and lime decompose cyanide solutions, the ordinary analysis of a mineral or ore to be treated by the cyanide process is nearly valueless to the cyanide manager, who needs to know what will take place when the finely-crushed ore comes in contact with the cyanide solution. In many instances such analyses do not show the presence of magnesium sulphate, although magnesia may be incidentally mentioned. When a finely-ground ore containing scorodite (ferric arsenate) is left in contact with a cyanide solution, a decomposition of the latter also occurs. In such event the solution becomes charged with arsenates, and the precipitated gold carries arsenic, which, under sulphuric acid treatment, causes evolution of poisonous arseniuretted hydrogen. The author proposed to overcome the injurious action of arsenates on cyanide solutions by adding excess of lime and a small quantity of sodium hydrate. All the arsenic would thus be precipitated as calcium arsenate.

Saturday, May 18th: Mr. W. R. Dowling, M.I.M.M., Vice-President, in the chair.—"Note on dust determination by filtration through sugar": A. McA. **Johnston.** The air is drawn through a 2-in. layer of coarsely-crushed loaf-sugar (from which everything finer than .006 in. has been sifted away) charged into a 25 c.c. glass separator and slightly moistened. The dust is estimated by dissolving the sugar in distilled water and filtering.—"New apparatus for sampling air for dust": E. J. **Laschinger.** The author described the apparatus designed by him, at the request of the Ventilation Sub-committee of the Miners' Phthisis Prevention Committee, in order to facilitate the rapid collection of air for the determination of dust held in suspension.—"A system of keeping underground costs and records": G. H. **Smith.** Under existing conditions it is generally impossible to form a correct estimate of the cost of doing any piece of work needed underground, and hence to choose the cheapest and best method of doing such work. The author, therefore, described in detail the system adopted at the Ferreira Gold Mine for keeping underground costs in such a way that they may be of practical use, and whereby it is possible to keep in touch with the cost of all work going on by means of tabulated cost sheets and graphic records.

Saturday, June 22nd: Lt.-Col. C. B. Saner, M.I.M.M., A.I.M.E., President, in the chair.—"The surface workers on the Rand, and their technical education": F. J. **Pooler.** The need was emphasised of having white men, technically trained, in charge of surface work on the mines. There was a supply available of fairly well educated youths for such a purpose. The conditions of living and pay did not seem unsatisfactory. Facilities were provided for technical training, but not as fully taken advantage of as might be expected. The institution of compulsory attendance of learners and apprentices at technical classes was suggested.—"Mine tributing in Rhodesia": W. **Anderson.** An account of the manner of letting small mines on tribute in vogue in Rhodesia, together with a description of the usual equipment and method of development and working operations and conditions of such mines.

Saturday, July 20th: Mr. W. R. Dowling, M.I.M.M., President, in the chair.—Presidential address: W. R. **Dowling.** The address dealt with the work done and influence exerted by the Society in the past, and particularly during the past year.—"Notes on the cyaniding of concentrate": R. **Linton.** An account of a series of tests made in order to determine the advantage or otherwise of cyaniding raw concentrate instead of transporting it to a customs smelter. The use of lead acetate appeared to be of no benefit in preventing the destruction of cyanide, although a small amount served to keep the solutions clear.

South African Institution of Engineers.—Saturday, April 20th: Mr. J. A. Yule, Vice-President, in the chair.—"The Cascade single and multi-speed motor": M. J. **Williams-Ellis.** A brief account was first given of early work carried out upon Cascade construction by Silvanus Thompson and others, after which the author proceeded to describe the single and the double type of Cascade induction motor, and its adaptation to mine and general work. References were also made to other multi-speed types of motors.—"The margin of safety required for man haulage at great depths": R. B. **Greer.** The author pointed out that the present margin of safety required by Government regulations in the Transvaal for man haulage was generally adopted as far back as 1877, when winding at great depths was not the common practice that it is now. He considered it advisable for the Government to modify the present margin of safety by a sliding scale after a depth of 2,500 or 3,000 feet.

Saturday, May 4th: Mr. F. H. Davis, President, in the chair.—"The commercial economy of turbine pumps": F. **zur Nedden** and H. B. **Maxwell.** A comprehensive account of the theory and characteristics of turbine pumps, and of the means to be adopted in order to ensure their efficient and economic working.

Saturday, July 13th: Mr. J. A. Yule, President, in the chair.—Presidential address: J. A. **Yule.** Attention was drawn to various efforts for economising labour in connection with the machinery used on the Rand Mines, both in respect of surface plants as well as of underground operations. The desirability was also pointed out, in view of the scarcity of agricultural labour, of inaugurating, under the Minister of Agriculture, a special department equipped with the most efficient farming implements, portable traction machinery, and deep boring appliances, for the purpose of being hired out to agriculturists at low rates.

Saturday, August 10th: Mr. J. A. Yule, President, in the chair.—"The execution of plans and drawings": Dr. W. **Glucksman.** The author held that the preliminary study of every object to be constructed should comprise four stages; (1) a forestudy in freehand, accompanied by an explanatory memoir, (2) a study in concert, being a development of the forestudy, geometrically true and constructed by means of drawing instruments, (3) a study of details, including a study of the nature and quality of the materials of construction, with all dimensions marked, and (4) a study of execution, including such points as the fit of moving or working parts, and bending or expansion.

Geological Society of South Africa.—Monday, May 13th: Mr. H. Kynaston, B.A., F.G.S., in the chair.—"Iridosmine from the New Rietfontein Mines; its analysis, occurrence, and genesis": C. B. **Horwood.** Iridosmine occurs in minute quantities, associated with the gold in the mines, which are situated about nine miles east of Johannesburg. Spectroscopic examination showed strong lines of osmium and ruthenium, but chemical analysis proved the presence of 45 per cent. of iridium in the osmiridium found in the concentrate. The author concludes the metals to be of secondary origin, occurring as primary segregations formed by magmatic concentration in the basic eruptives occurring in the mines; and that by the last phase of eruptive activity they were extracted from the dykes by superheated gases. Subsequent hydrothermal action probably operated in concentrating them in the banket reefs.

Monday, June 17: Mr. H. S. Harger, President, in the chair.—"Topography and Geology of the German South Kalahari": Dr. P. **Range.** The county described consists of an uninhabited northern portion and an inhabited southern portion, bordering on Gordonia and Bechuanaland. The entire country is an immense plain, and the author's object in his journey was to discover the nature of the older rocks hidden under the prevailing surface deposits. Those rocks belong to the Nama and Karroo formations, almost completely covered by a deposit termed "Kalahari limestone," but really a calcareous sandstone, on top of which lie the reddish Kalahari sands, the layer of sand averaging about 15 feet in thickness. Below the upper strata, the author is convinced, an extensive underground water supply exists, and doubtless the country, as well as the adjacent parts of Gordonia and Bechuanaland, formerly misnamed "desert," will yet become the home of a large number of well-to-do farmers.—"Notes on a specimen containing Bastnäsite and Wolframite from Welgevonden:" D. P. **McDonald.** Bastnäsite, a fluo-carbonate of the cerium metals, has been found fairly widely distributed in the vicinity mentioned. It is associated with wolframite, and also with tourmaline, in which the larger crystals are embedded. It is also found together with orthite, as was the case where it was first described, in Sweden. The wolframite is of relatively late origin, formed by the alteration of scheelite and associated with calcite. The deposit, the author concludes, is of pneumatolytic origin.—"Note on the relationship between the Black Reef Formation and the Ventersdorp diabase": C. B. **Horwood.** At Randfontein, 27 miles west of Johannesburg, the author has found Ventersdorp diabase intrusive in the Black Reef Formation. Through the typical bluish-black quartzite of the latter formation tongues of diabase have forced their way, and two or three feet of shaly diabase may be seen overlying this quartzite, and underlying some eight inches of the quartzite which has been bleached white and rendered fissile. Near Robinson Station the diabase had broken right through the quartzite and poured over its surface. In other localities it may also be seen overlying the Black Reef conglomerate. Apparently, therefore, the eruptive activity of the Ventersdorp period did not entirely die out during the time that the Ventersdorp System was being laid down, but extended into that period to which the Black Reef Series belongs.

South African Institute of Electrical Engineers.—Thursday, May 23rd: J. H. Rider, V.P.I.E.E., President, in the chair.—"The design and installation of transformers from an operating point of view": C. W. R. **Campbell.** Dealing principally with three-phase transformers, practical observations were made with regard to their designing, transport and installation. Every transformer of any importance should be fitted with a thermometer pocket and a thermometer, of which constant readings should supersede the practice of judging the temperature by hand.

SOUTH AFRICAN METEOROLOGY: WEATHER FORECASTING.

By Adolph Gislingham Howard, M.S.A.

Although the title of this paper is the same as that chosen by the President of Section A in his address delivered on the 5th of July last year, it does not in any way clash therewith. The Rev. Mr. Goetz has very fully explained the origin and progress of weather forecasting in Europe and America, and has also quoted, to a certain extent, from the officer who was in charge of the forecasting at Johannesburg. The present paper continues the subject, and refers solely to the practical side of weather forecasting in South Africa.

The writer of this paper has studied the question for a great number of years; about 25 years ago he used to send forecasts to an evening paper, based upon similar data to that which is now available, and met with a fair amount of success; the service was discontinued owing to the closing down of the paper.

As far as can be ascertained these were the first weather forecasts ever issued in South Africa. Many years afterwards the Transvaal Observatory began to issue forecasts embracing its own Province, but none until now have been issued in the Cape Province since that time.

One great drawback to working out weather forecasts for the Cape Province is the paucity of observing stations. The area embraced by the forecasting service, leaving out the Transvaal for the present, extends from Clanwilliam, along the south-west, south, and south-east coasts to Natal, its inland boundaries extend from the Cedarbergen across by the Karoo Poort and along the edge of the Upper Plateau, which is bounded by the Nieuwveld, Stormberg, Sneeuwberg and Drakenberg ranges. This area is divided into four districts:

1. *The South-West,* the easterly limit of which extends from Cape Hanglip, along the Zondereinde River Mountains, and follows the 20th meridian until it cuts the northern boundary.

2. *The South Coast*; the east boundary extends from the mountains to the east of Graaff-Reinet, south of Somerset East, and along the Zuurberg Range to Fish River mouth.

3. *The South-East*; this includes Western Transkei and is bounded by the canyon of the Umzimvubu or St. John's River

4. *Natal*; all the coast land north-east of the last-named boundary.

None of these districts is small, and yet the observing stations are few and far between. For the south-west we have Clanwilliam, the Observatory and Cape Point; for the south coast, Cape Agulhas, Cape St. Francis and Port Elizabeth; for the south-east, East London only; while for Eastern Transkei and Natal, Durban has to suffice. Until recently Port Nolloth used to supply readings, these were temporarily suspended, but have now been resumed; this station is situated in the north-west district, for which forecasts are not issued.

And yet from such meagre information much has been gleaned, and we have now a fair knowledge of the motions and forms of areas of low and high pressure, and it is possible to forecast weather with a degree of certainty out of all proportion to the data. We live in the hope of seeing more observing stations instituted and more extended information supplied from each. Since the 15th of April this year the morning forecasts embrace the Transvaal and the northern portion of the Orange Free State, this area being divided into districts 5 and 6.

The procedure adopted for issuing these forecasts is as follows: At all the stations enumerated, except from Transvaal, pressure, temperature, wind and rainfall observations are taken at 8.30 p.m. and 8.30 a.m.; Transvaal observations are taken at 9 a.m. only. Between 9 and 10 a.m. these are wired in code to the Meteorological Office in Cape Town, where they are decoded and entered in a book. From this information the forecaster complies two weather charts, one for the evening and one for the morning. Then he has to study the distribution of pressure, direction of winds, temperature changes and so forth, and with the experience of his past investigations to guide him, he can see what the synoptic conditions prefigure in the way of weather changes. The forecast is then written out for the six districts and a copy thereof is attached to a notice board at the office for public inspection, and is wired to various places in South Africa. The word forecaster is mentioned, but in fact there are at present two, one with Cape Province experience and one with a knowledge of Transvaal weather.

Each prediction is verified on the following day, and once a month the percentages of successes or failures are worked out

Thus far the routine work; we will now consider forecasting itself.

Atmospheric pressure is taken to be that at sea-level, and for this purpose each reading has to be corrected for instrumental error and temperature, then reduced to that plane. Temperatures are not so reduced.

When studying an isobaric chart the main points to be noted are the positions of the areas of high and low pressure, as well as their shapes. Pressure is the most important element in forecasting, although, of course, other phenomena have their values.

As a broad and general rule areas of high pressure bring fine weather and those of low pressure rain or unsettled weather. No hard and fast line of demarcation between high and low can be given; the 30.00 ins. isobar has been looked upon as a convenient zero for departure, and so it is, but the whole matter of highs versus lows is one of comparison. Still, when extremes are reached we are on surer ground; in South Africa the critical sea-level pressures seem to be 29.80ins. and 30.20ins.

Summer Months.

Let us consider areas of low pressure. Leaving out of consideration the Monsoonal tongue and the few Indian Ocean lows, the whole of our depressions come from the west or south-west; they are generally in the form of an inverted V, with one, two, or even several apices; when one of these is approaching from the south-west, pressure over the south-west decreases rapidly; the distribution of pressure may be that of a low interior and a pericyclonic ring of high pressure round it, purely summer conditions, wind may be east at Cape Agulhas, south-east at Cape Point, and south at the Observatory, but all over the south-west pressure is yielding, and this can only be caused by the presence of a depression to the south or south-west. In any such case one would be safe in forecasting the approach of a depression which should be found on the South Coast either the next morning, or, if the movement lags, on the following one.

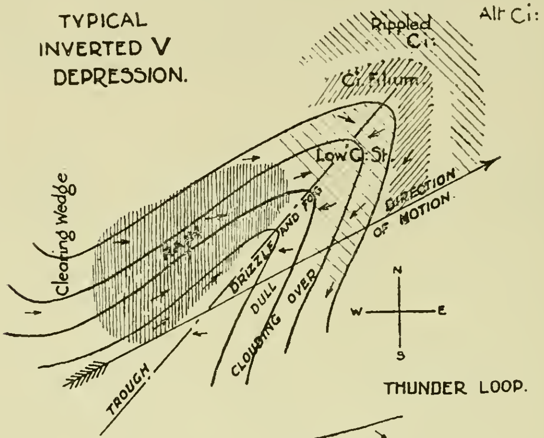
The forecast would be,—little change over the south-west, slight fall of barometer, wind west or south, sea mists or fogs. South Coast; pressure yielding, warmer, winds east, with clouds next morning. A similar forecast would apply to the south east and probably to Natal.

When the V is seen to extend on to the south coast it will be well to assume that it is the foremost apex of a series and look for following ones; should pressure be fairly steady over the south-west another V will appear, but if it be increasing rapidly a high pressure area will most likely appear. When a succession of V apices pass the rainfall is spasmodic and very local in distribution, accompanied by a few thunderstorms.

In the case of steady pressure over the north-west the forecast would be,—continuation of existing conditions over the south-west; westerly winds with unsteady pressure and temperature round the south coast and eastwards with possibly local thunder and rain. Over Natal the wind would change from north-east to south-west with increase of pressure, decrease of temperature, and probably thunderstorms.

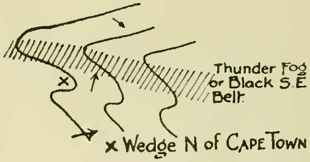
Similar conditions would be repeated until a decided increase of pressure developed over the south-west, when rain might be looked for all along the coast and Natal.

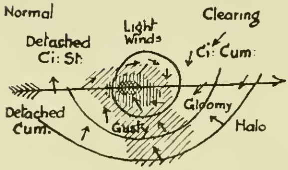
Should a subsidiary V develop, extending from Mossel Bay to the neighbourhood of Tulbagh or thereabout, rain may be looked for over the western half; that to the south-west may reach the Peninsula and extend to Clanwilliam.

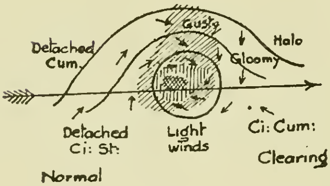


TYPICAL INVERTED V DEPRESSION.

THUNDER LOOP.







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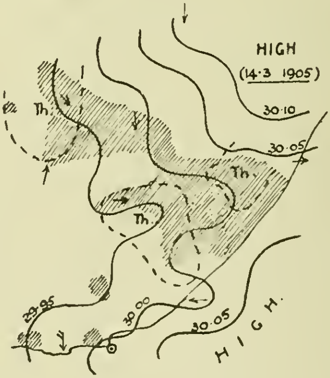


EASTERN RAIN AND THUNDER LOOP.

When the last of the series of V depressions has passed off to the east the high usually follows as a wide egg-shaped tongue with south-west winds along the coast and south east winds over the interior; the greater the difference between the low and the following high the greater the probability of rain falling, so that in such a case rain should be forecast for the south coast from Cape Agulhas to the Eastern Province, extending inland.

The foregoing is a general sequence of weather conditions due to the passing of depressions. Two depressions are seldom alike, and yet all are based on the same broad principle.

Another form of depression is one of a cyclonic character which affects the east coast and Natal. It is caused, no doubt, by a cyclone in the Indian Ocean, moving from the north-east and recurving in about the latitude of Durban. When such a depression is seen to be to the north-east of Natal the winds there blow easterly and pressure decreases, the heat often becomes intense, especially as the V from the depression pushes down over the land between the sea coast and the high mountain chain. When pressure begins to increase, the wind goes to the south-west and the change is usually accompanied by heavy downpours of rain and violent thunderstorms. Often these affect the coast lands as far as the south-east of the Cape Province.

Normal fine weather conditions exist when a belt of mean pressure rests over the south coast lands from the south-west to Natal, with areas of higher pressure over the South-West Ocean and Eastern Transvaal. Pressure must not be increasing or decreasing rapidly. When such a condition exists the forecast is for fine weather generally, winds southerly over the south-west, westerly along the south coast, south-westerly at Natal, and northerly in the Transvaal and the Free State. Then watch the south-west for a change.

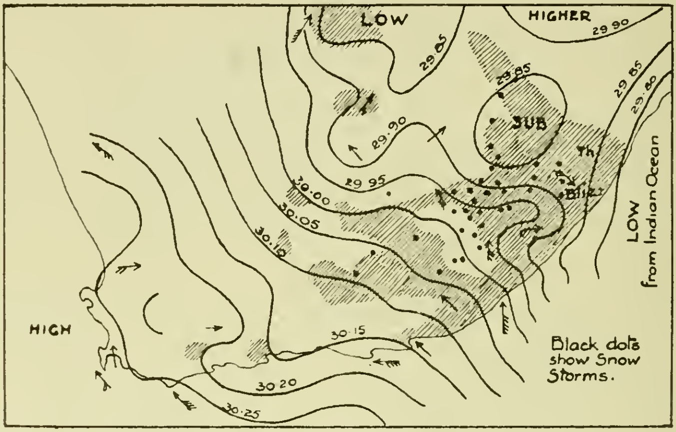
The causes bringing rain over the Inland Plateau are somewhat obscure, but there seems reason to believe that after pressure has been low and temperature warm, if a high pushes up suddenly with steep gradients from the south coast to the interior, accompanied by a fall of temperature, rain and thunderstorms will prevail over the plateau.

Areas of very high pressure are generally indicative of fine, clear weather, dry, hot days, and cool nights; light winds and no rain. At the same time if secondary loops are found, these will moderate the weather.

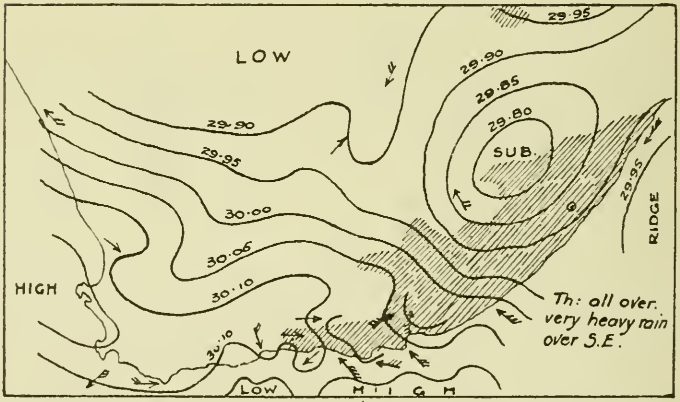
When secondaries are passing they make their presence known by cirro-cumulus in the sky; this is an unfailing portent; when they pass to the south, generally moving from a westerly to an easterly point, they are upon the northern gradients of an anticyclone and cause indications of rain to disappear, at any rate they make for fine weather, except that they increase the intensity of south-east winds; this is because their central and southern regions are then the wet areas, their northern ones being the homes of cirro-cumulus and following cirro-stratus clouds. They seldom pass to the north of the Peninsula, but along the south coast they sometimes move over the land, when the conditions are suitable they bring rain.

For instance, should a secondary be seen to the north of Cape St. Francis, wind at Port Elizabeth will likely be S.E.; as the low area passes to the north of that town wind will go to the S.W. and very heavy rain will probably fall. Such secondaries are the cause of most of the coastal floods.

As an example the flood of the 16th November, 1908, may be cited; at 8.30 on that morning an anticyclone was over the



BLIZZARD OF 31ST MAY, 1905.
SHEWING
INDIAN OCEAN LOW.



PORT ELIZABETH FLOOD – 16TH NOVEMBER, 1908.

southern ocean; wind was S.E. 3, at Port Elizabeth; E. 3, at Cape St. Francis; S.E. 4, between there and Knysna; and W. 1, at George and Oudtshoorn. At Dunbrody, to the N.W. of Port Elizabeth, wind was S.W.5; these directions showed the presence of a secondary to the north-west of Cape St. Francis and another north of Port Elizabeth joined together, no doubt, by a "col." There were indications of other secondaries further to the east, while the upper tongue of an inverted V was to the south of Knysna and a "sub" over the north-east, and the Transkei. Conditions were, therefore, in favour of rain along the South and East Coasts, on to Natal. The secondaries moved eastward and to the north of Port Elizabeth, where the wind chopped round to the S.W.; torrents of rain fell, which flooded the Baakens River and caused an immense amount of damage.

During summer months or even well into winter or spring, rain often falls with pressure low inland and easterly winds blowing along the Coast; the conditions are high pressure over the Transvaal, high to the south or South Coast, with a loop between open to the west and north-west, but closed to the east; this is the Eastern Province summer rain and thunder loop, and when properly developed seldom fails to bring rain and thunder. The cause, is, no doubt, due to its being the home of innumerable secondaries.

The writer separates the term "sub"* from that of a "secondary"; the former is in reality a minor depression with closed isobars, differing from the latter. It is cyclonic in character, and very often will form, deepen and die away without changing its position. Its weather conditions are thunder, hail, snow or gales, according to the season and place. They are common in wide "cols" separating areas of high pressure.

During most of the year a "sub" rests between Cape Town and Clanwilliam, not a moving one but one which forms, disperses and reforms; and here are developed conditions for thunder, fogs or black south-easters. Should the sea level pressure at Clanwilliam and Cape Town be about the same, with a N.W. wind at the former, W. or N.W. at the latter, and southerly at Cape Point, these indicate a wedge to the north of Cape Town extending from the north-west into the "sub"; this forms a fog wedge, and is often followed by fogs on the South-West Coast. It also indicates an electrical condition, and should a south-easter spring up it will be a "black" one.

The circulation of wind is often from the eastward at Cape Agulhas, moving round Cape Point towards the north-west; it thus blows from above the warm Mozambique sea current to the cold Antarctic one, and, as a consequence, fogs are prevalent over the ocean to the west. When a wedge, as before mentioned, is developed, this current of air is deflected and comes on to the West Coast, carrying its fog producing powers.

* Subsidiary Depression.

Wherever opposing currents come into contact thunderstorms are likely to occur; thus, along the low trough of a V, or on a "col," and the more wedge-shaped the adjoining high pressure spurs the greater the probability of thunder. Similar conditions during winter will bring snow where the altitude is suitable.

Winter Months.

During the winter months the southerly depressions are felt more over the Western Districts and along the Coast. The anti-cyclones are greater in pressure and the generating cyclones of the Antarctic Ocean further north, so that the pressure gradients in a depression must be steeper, and, as a consequence, the wind stronger and the rainfalls heavier. No matter what the distribution of pressure be, if it is yielding over the South-West and North-West winds be blowing there, it prefigures the approach of a depression. The prediction for the South-West would be: fresh to strong N.W. winds to continue, with sky becoming more and more clouded.

Generally an area of high pressure rests over Namaqualand, tailing down towards Cape Agulhas; therefore many depressions pass, one after another, while the wind in Cape Town remains N.W.

If the chart shows a V to the east of the foregoing high, and there be a low area over the western ocean, full winter conditions exist. Then forecast stormy weather, with westerly winds and rain all over the South-West and from Cape Town along the South Coast to Port Elizabeth. Should the wedge be misplaced, and the trend of the isobars be all from S.W. to N.E., predict rains all over, as far as Namaqualand, and possibly to the east of the Cape Province. Such a condition will bring snow on to the mountains. As in summer, when pressure increases rapidly in the rear of a depression, the rain is more plentiful and the winds stronger.

Rain seldom falls within a very high pressure area, unless it be following in the wake of a depression, or if a secondary loops into it. This should be noted, and possible rain predicted accordingly. High pressure areas bring cold nights, so that for stations where frost is prevalent in winter, frosts should be forecast until such time as pressure yields.

Generally high pressure areas bring fine weather, with temperature above the mean during the day, and below the mean during the night. Dews and frosts at night are common, and haze or fog during the day.

If a high follows a V and covers the whole of the Interior, squeezing the Monsoonal tongue into a narrow strip covering the Orange Free State down to the north-east of the Cape Province, being bounded by a low isobar, forecast snow on all high lands to the north-east, Basutoland, etc. The probabilities will be greater if pressure is low over the Transkei, or if an Indian

Ocean cyclone is affecting Natal and the Transkei. As an example the blizzard of the 31st of May, 1905, may be mentioned. The chart for the 30th indicated low pressure all over; the monsoonal tongue was narrow and bounded by the 29.90 isobar, a low was over the south-east ocean, and a "sub" over Basutoland. Pressure was increasing rapidly to the south-west, but falling elsewhere; gradients were thus getting steeper. That day rain was general over every District, and snow fell at all high stations to the east and north-east of the Cape, including Basutoland. On the 31st a high anti-cyclone was over the west and south, moving rapidly eastwards; at the same time pressure had decreased considerably over the north, north-east and Natal; at the latter place a depression from the Indian Ocean increased the intensity of the weather. The monsoonal tongue was now very low, and the "sub" over Basutoland was bounded by the 29.85 ins. isobar. Very cold and strong winds prevailed. and snow continued to fall over the high lands to the north-east, including Basutoland. A blizzard swept across Upper Transkei and Natal, doing much damage.

Owing to the distribution of high and low pressure during the winter months secondaries have their steepest gradients to the north, so that the storm and rain bringing area is central and to the north thereof. They thus have a tendency to increase the rainfall, or even to bring unexpected rain when no indications appear of it on the chart. With our present limited knowledge it is impossible to forecast the appearance of a secondary, but when one is seen it can be dealt with by bearing in mind that the core is always a circular area where rain is almost constant; this area extends towards the region of higher pressure, and intensifies the existing rainfall. Towards the region of lower pressure weather has a tendency to clear temporarily and winds to get lighter. Thus by knowing the general distribution of pressure within which secondaries exist, we can foresee what the results will be.

Generally.

There are other forms which isobars assume beyond those enumerated, but, as far as the Cape Province is concerned, they have not been studied to the same extent. The Wedge is a very common form; these extend from all points of the compass, but in each case the extreme point is termed the Crest, and here thunderstorms are to be looked for during summer. Along the centre of the wedge fogs are to be expected, but these are not always certain away from the coasts. A wedge occurring between two depressions will cause a sudden clear up when indications have existed for rain, so that if such a sudden clear-up occurs, look for the appearance of a following depression.

Between two areas of high pressure or two of low there is an intermediate region called a "Col," and in such a region winds are in opposition, vertical air currents are also irregular, so that secondaries are common. It, therefore, comes about that where a "Col" exists one must look for local disturbances, such as unsettled weather, rain or thunder, but, of course, the season of the year must be taken into account in making a forecast.

Line squalls, thunderstorms, hail storms, non-isobaric rains, etc., are subjects of which very little is known in South Africa; much investigation will be necessary before we can speak upon these with confidence, and with the meagre data available this is likely to be postponed indefinitely. One or two remarks may, however, be hazarded. Line squalls are not of frequent occurrence, even when the configuration of the isobars indicates them, in most cases a secondary V or wedge, associated elsewhere with such squalls, merely leads to fog. The "black" south-easter of the Cape Peninsula seems to be often associated with such forms of isobars. The so-called "tornado" at Malmesbury on the morning of the 29th of September, 1905, was a line squall, as the isobars for that morning clearly prove.

Thunderstorms follow where line squall isobars exist, in "cols," at the apex of a wedge, or where winds are opposed and temperature conditions are suitable. Thus, if during summer a fog wedge shews on a chart, it is safe to say in the forecast that thunder conditions exist and that thunder is probable. Again, if a very narrow "col" is seen, thunder can be forecast, the narrower the "col" and the closer the wedge apices are together the more the probability of thunder. Large open loops are the homes of secondaries, and thunder can be forecast during summer. In forecasting such storms it must be borne in mind that certain parts of the country are more subject to storms than others.

Where thunderstorms are prevalent hail can be looked for, but so far it is impossible to say whether any storm will be accompanied by hail or not. One thing seems to be clear; hail storms do not change their position in a depression with reference to the configuration of the isobars, but move with the depression, and as most of these travel from S.W. to N.E. so must of our hail storms follow a similar direction.

The forecaster must bear in mind that slow changes in existing barometrical conditions prefigure a continuance of existing weather, be it fine or unsettled; quick pressure changes foretell rapid alterations in weather conditions. Stagnation anywhere will charge the atmosphere with moisture and lead to fogs, mists and drizzle rain.

Pressure increasing rapidly is often followed by a depression; while a slow increase makes for fine weather. Slow increase after the rain of a depression has begun gives merely drizzles and a slow clear-up. Therefore, bear in mind,—slow rise slow clear, quick rise quick clear. Look towards the ruddy glow in the clear sky after sunset, that is the direction from which to expect the wind to blow.

Cirrus clouds move from a westerly direction over the Peninsula; if they back to the north-west look for a depression, if they veer to the S.W. or S., a high is approaching or a black S.E. "low" between Cape Town and Clanwilliam may be forming.

When E. or S.E. winds blow over the Eastern Province, a depression is approaching from the south-west, then forecast rain when they go to the W. or S.W.

The foregoing embodies some of the general principles of weather forecasting in the Cape Province; the writer is not conversant with the conditions governing the weather changes over the Transvaal or the Upper Plateau; it is hoped that in time observing stations will be inaugurated upon the latter and that our knowledge of the weather progression will embrace the whole of South Africa from the Zambesi to Cape Point.

Resources and Industries of the Cape Province.—On page 356 of the last volume the publication of Mr. Somerset Playne's work on the History, Commerce, Industries and Resources of the Cape Colony was noted. So handsome and profusely illustrated a book, however, calls for a more extended reference. It is the outcome of personal visits to numerous farms in the area dealt with, and includes over 2,000 photographs and descriptions of many of the most important farms in the country, together with specially written descriptive articles on such subjects as cattle, ostriches, tobacco, viticulture, the Native races of the Province, its fauna, flora, meteorology, and varied aspects of colonial life, activity and progress, all arranged in a manner such as to render the whole compilation not only valuable for reference purposes, but also greatly interesting to everyone who occupies himself either in aiding or watching the advancement of the Province and of the Union as a whole. The contributors include such well-known names as those of Messrs. Oscar Evans, P. R. Malleson, Prof. P. D. Hahn, C. G. Lee, W. C. Scully, and the Librarian of the Royal Colonial Institute, the last-named contributing an article on the literature relating to the Cape Province.

Aircraft.—In a work on "Monoplanes and Biplanes; their Design, Construction, and Operation," which is published by Sampson Low, Marston & Co., Mr. G. C. Loening, B.Sc., discusses, among many other phases of aircraft, the view that many of the accidents which befall airmen are avoidable, a view which he strongly defends, notwithstanding the many fatalities that are constantly occurring. The firm just mentioned also publish a work on "All the World's Airships," by Fred. T. Jane, who has become well known in connection with the annual publication of "The Fighting Ships of the World."

THE USE OF WOOD ASHES FOR MANURIAL PURPOSES.

By Arthur Stead, B.Sc., F.C.S.

In using wood ashes as a source of potash it is necessary to consider the climate. In moister climates, a thorough incorporation with the soil is all that is necessary, but in dry climates like that of Bloemfontein and other parts of South Africa, special precautions must be taken to prevent harmful effects. The fact is that potash salts are "brack" salts, and any addition of them to the soil results in an increase of the amount of "brack." There are several kinds of brack salts; but the commonest are sulphates, chlorides, and carbonates of soda and potash. Of these the sulphates are the least harmful, while the carbonates are very injurious. Now wood ashes contain a large percentage of carbonate of soda and potash (*i.e.*, Ganna Bosch ash contains about 40 per cent. of these substances), therefore in applying wood ashes as manure the farmer must always remember that he is adding excessively injurious substances to his soil. The carbonates of soda and potash injure the bark tissue and sometimes destroy it altogether. Such a plant, if pulled up, will be found to have a dark ring of varying width round its stem, usually just below the surface of the soil. This dark ring is easily rubbed away, because the alkali has softened it. The plant is, in a word, ring-barked, which is one reason why it dies. Carbonates of soda and potash are also able to prevent the germination of seeds. Seeds are also softened and destroyed just in the same manner as the bark of the plant is. Lucerne seeds, and also the young plants, are very liable to destruction if any appreciable quantity of these compounds is present in the soil. The drier the weather, the nearer the surface and the more concentrated will these compounds be, and the more destruction will they cause. These same carbonates of soda and potash also prevent the growth of certain soil organisms which are necessary for abundant growth. Among these organisms are the inhabitants of the tiny nodules to be found on the roots of peas, beans, lucerne, sainfoin, etc. These organisms obtain nitrogen for the plant from the air. If therefore their growth is prevented the plant suffers. Again, very small quantities of these carbonates of soda and potash have a bad effect on the texture of the soil. They tend to puddle it. Now a completely puddled soil will let neither water nor air pass. If, now, one portion of a field is dressed with ashes and another not, that which is not treated will remain more open than the other, and air and water will therefore pass through it more easily.

This may be what is causing the trouble with lucerne patches that have been treated with ashes. On that portion where the ashes have been applied, the rain, irrigation water, and air do not penetrate so well, and in consequence the crop does not do so well as on the untreated portions. This trouble is to be looked for especially in soils containing much clay or fine silt. Many of the black-looking soils from the Thabanchu and Ladybrand districts are of this nature. If this is not the cause, then one of the other causes mentioned above may be operating. The remedy in all cases is to destroy the carbonates of potash and soda by transforming them into sulphates. This is done by applying gypsum and water. In the presence of water and air, gypsum and carbonate of soda yield carbonate of lime and sulphate of soda ($CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$).

In the same way gypsum plus carbonate of potash gives carbonate of lime plus sulphate of potash.

The gypsum should be ground to a fine powder and applied at about the same rate as the ashes were. It is necessary to incorporate it with the soil and to keep the soil loose. Rain or irrigation will do the rest. I very much doubt if gypsum can be obtained at a reasonable price. Under the circumstances it will perhaps be best to apply superphosphate, which contains a large percentage of gypsum. This will also add phosphoric acid to the soil, from which the crop will derive extra benefit.

It is, however, better to prevent than to cure. I would therefore recommend any one who would use ashes for manurial purposes to mix them with an equal weight of gypsum or of superphosphate, and to apply the mixture well in advance of planting the crop. This applies equally well to potatoes.

The treatment converts the carbonates of soda and potash into sulphates of soda and potash, which latter compound is the best form of potash to apply to crops in which "quality" is an essential, and the only form of potash which can be used in safety in a dry country.

Composition of the Earth's Upper Atmosphere.—On pages 210 and 211 of the previous volume allusion was made to the hypothesis that the outer layers of the earth's atmosphere consist almost entirely of hydrogen. A. Wegener* estimates that the hydrogen layer begins at a height of 70 to 80 kilometres above the earth. The spectrum of the aurora shows that as the height increases the intensity of the nitrogen lines diminishes, and that of the hydrogen lines is increased. At a height of 200 kilometres, he thinks, the atmosphere consists of equal parts of hydrogen and coronium, the latter predominating at greater heights.

Zeitschrift anorgan. Chemie, 1912, vol. 75, pp. 107-131.

THE INDIGENOUS HIGH FOREST SITUATED IN THE DIVISIONS OF GEORGE, KNYSNA AND HUMANSDORP, CAPE PROVINCE.

By John Spurgeon Henkel.

Introduction.

As from time to time enquiries have been made about the indigenous forests belonging to the Government and situated in the divisions of George, Knysna and Humansdorp, it occurred to the writer that members of the South African Association for the Advancement of Science, as well as others, would be interested in a short description of the forests and a statement of the system of management. This paper does not deal with the botanical aspect, but treats briefly with the distribution of the high forest, and explains the system of management practised.

The writer has based his account on observations—by no means complete—made during the past three years, but it is hoped that sufficient data will be supplied to give an idea of the nature of the forests; their relation to other woodlands of the world; the method of managing, utilizing and protecting them as practised at present.

Tract of Country Referred to.

The tract of country in which the forests occur lies between Long. 22° 10′ E. and 24° 20′ E. and Lat. 33° 50′ S. and 34° 10′ S., corresponding with Great Brak River in the west and Clarkson in the east. The area is bounded on the south by the Indian Ocean and on the north by the Outeniqua—T'Zitzikama—Karedouw Mountains. The range is a continuation of the Lange Bergen, and has an average height of about 4,000 feet. There are numerous peaks, the more important of which are:—Cradocksberg, 5,176 feet; Hoogeberg, 4,666 feet; Formosa, 5,500 feet.

From Peak Formosa the range gradually decreases in height until it merges into the coastal plateau or terrace which extends from Brak River to Cape St. Francis. The range generally runs east and west, and has two spurs—of great significance—bending S.E. towards and terminating on the coast. The first spur occurs a few miles east of George, and the second terminates midway between Knysna River and Seal Point. The mountain range is a series of folds, gradually decreasing in height southwards. The area is intersected by numerous streams and deep ravines. The coast-line is precipitous, except between Kaaimans River and Knysna Heads and a small portion at Plettenberg Bay.

Geological Formation.

The area lies in the folded belt of the Table Mountain Sandstone series. The higher points are all of this formation.

In the George portion of the coastal plateau granite, Malmesbury and Bokkeveld series are met with. In Knysna and Humansdorp the dominant area is Table Mountain Sandstone, but strips of Bokkeveld series occur as well as conglomerates, sands, surface clays and gravel. The soils present are those usual to the formations mentioned. On the upper slopes of the mountain range and the ridges and kopjes of the foothills the soil is usually very shallow, but on the lower mountain slopes and the foothills the soils are deeper, but in hardly any case may they be considered deep. An ironstone pan is frequently present about two feet below the surface.

Climate.

The climate is mild. In winter the mountains occasionally are covered with snow; frosts occur in low-lying depressions; hail is comparatively rare, as also are thunderstorms. The rainfall is usually in the form of light rains falling throughout the year, but more abundant during late summer and spring. Only occasionally do heavy downpours occur.

At various centres situated within the area described meteorological observation stations have been established, and from some of these the following data have been obtained.

The average annual rainfall on the foothills and coastal plateau is:—

Town of George: 1 station (10-year period), 37.47 in. with 115 wet days.

District of Knysna: 5 stations (10-year period), 41.54 in. with 100 wet days.

T'Zitzikama: 3 stations (10-year period), 47.42 in. with 113 wet days.

The rainfall fluctuates, as will be observed from the following figures obtained from Buffels Nek—elevation 2,200 feet, Lat. 33° 53′ S., Long. 23° 10′ E., for period 1894 to 1911:—

47.34″, 39.25″, 52.31″, 45.88″, 44.26″, 37.59″, 41.82″, 52.61″, 60.83″, 41.61″, 51.02″, 65.50″, 52.34″, 36.37″, 53.78″, 50.73″, 43.22″, 45.63″.

The area is subject to warm, desiccating winds from north and north-west, which occasionally blow with considerable force. These winds may last for a few hours or continue for three days—usually they are followed by rain. If long-continued the vegetation becomes inflammable, and frequent veld and forest fires occur. The most disastrous fire, causing considerable destruction of forest, was that of February, 1869.

Vegetation.

The vegetation is divisible into two main classes of woodland, namely, the sclerophyllous woodland characteristic of the south-west, and consisting, for the most part, of sclerophyllous evergreen woody plants and high forest. The high forest occurs in detached or semi-detached patches or groups varying in size from a few square yards to thousands of acres in extent. The high forest consists of evergreen trees, partly light-demanding and partly shade-enduring, the more important trees being:—*Ocotea bullata, Podocarpus elongata, Podocarpus thunbergii, Cunonia capensis, Olea laurifolia, Nuxia floribunda, Curtisia faginia, Platylophus trifoliatus, Apodytes dimidiata, Pterocelastrus variabilis, Gonioma kamassi, Virgilia capensis,* and many others not occurring so frequently. The understorey of shrub growth consists principally of *Trichocladus crinitus,* and in places numerous tree ferns occur.

The high forest is distributed in three main groups, which may be called respectively the George, Knysna, and T'Zitzikama groups.

The George zone of high forest commences in the foothills forming the eastern headwaters of the Great Brak River, about ten miles from the sea, and follows the foothills of the Outeniqua Mountains, passing the town of George and terminating at the Wilderness (Touw River Mouth). The approximate area of indigenous high forest in this group at present is about 7,000 acres. A large area has been destroyed by fire since European occupation. The greatest area of forest is at the eastern extremity of the arc.

The Knysna forest zone commences on the Touw River, distant about three miles from the sea, and follows in an arc the foothills of the Outeniqua Mountains and the spur already referred to, which terminates on the coast midway between the Knysna River Mouth and Seal Point. The area of high forest contained in this group is approximately 70,000 acres. The greatest area of forest is along the eastern half of the arc, and for the most part covers the watershed.

The T'Zitzikama high forest zone commences at Keurbooms River, about two miles from the sea, and follows the foothills of the T'Zitzikama and Karedouw Mountains as far as Clarkson, about seven miles from the sea. The area of forest is about 35,000 acres. Large areas have been destroyed by fire in this zone. The patches of forest are more or less evenly distributed along the western portion of the arc, but diminish in size eastwards—east of Clarkson they disappear.

In the three areas there are, therefore, approximately 112,000 acres of forest, about 92,000 of which belong to the Government.

The three groups form arcs with radii pointing S.W. The radii of the arcs increase in size from George eastwards.

Since European occupation the area of high forest has decreased—due entirely to recurring fires—and in some cases cultivation of the soil subsequent to the fires, the greatest destruction being in the George and T'Zitzikama districts. Possibly about 10,000 acres have been destroyed.

The district of Knysna contains perhaps the most typical type of forest, as it does the greatest area. The largest forest—known as the Main Forest—covers the ridge extending from Buffels Nek to Harkerville—a distance of about thirteen miles. Clearly, therefore, the forest does not owe its origin to telluric water.

Eastwards and westwards of Knysna the forest patches decrease in size, the individual patches being more isolated, and generally situated on protected slopes and in ravines and along water courses. Possibly owing to more unfavourable conditions—less rainfall—they are unable to withstand the frequent injury from fire to which they are exposed.

The high forest zone lies between 500 and 2,000 feet above sea-level, but in places the forest extends down to sea-level principally along the river banks, and above the 2,000 feet upper limit patches of forest occur in the deep mountain ravines well protected from sun and wind. A further characteristic of the forests is that they usually occur on the southern and eastern slopes of the foothills, the best patches usually being on the eastern slopes of the kopjes forming the foothills.

The forest is usually only of one type, in favourable localities containing trees 140 feet high; in less favourable situations the height decreases, and along the coast, where rainfall is deficient, the high forest may not be more than 12 to 20 feet high.

Principal Cause of Injury and Natural Protection.

From a study of the typical example of the annual rainfall, namely, that of Buffels Nek, it would seem that at no period does the rainfall diminish to an extent seriously to injure the development of the forest trees. Indeed, the size of many trees, and the uniformly good quality of the timber cut from them shows that growth has been regular over long periods.

If one leaves out of consideration injury caused by game, rodents, insects, woody parasites and fungi, the most serious factor militating against the natural maintenance and extension of the high forest is that of fire either caused by natural means or by the agency of man. In ordinary seasons the high forests may be said to be free from injury by fire, but at seasons of low rainfall combined with desiccating winds, and the consequent inflammable nature of the vegetation, a very serious danger arises. At such seasons a fire may, and does, cause serious injury. The injury most frequently is confined to the N. and W. perimeters, rarely on the S. or S.E. If the period of dry weather has been protracted, a fire penetrates far into the forest, but otherwise only the perimeter is injured. One or two fires may not be serious, but it is their frequency which is the trouble. A fire may at first only slightly injure the forest curtain, but, unfortunately, as a result of the burning a luxurious weed growth follows, and when this becomes dry and is ignited again irreparable damage is done to the fringing trees, which, as a rule, die and become food for further fires. The forest perimeter most liable to injury is that situated at the junction of the mountain ravines with the coastal plateau—thus the most serious damage occurred at George, Forest Hall, Coldstream and Storms River. The forests protected by ridges and hills from the N.W. winds are comparatively free from injury, the reason being that the aspect is favourable for the conservation of moisture and the production of counter currents of wind.

The periodic fires caused by natural methods would not seriously affect the area of forest, though the forest expansion may or may not be hindered. It is even possible that periodic fires may be responsible for the increase in high forest, but sufficient data are not available to establish this point. At any rate, Nature has provided a remedy for what is evidently a long standing menace—she produced, or introduced the keurboom (*Virgilia capensis*).

The Keurboom is a rapid grower, seeds freely and continuously. The seeds are eaten by birds and disseminated far and wide. They possess the power of lying dormant for a long period, and are capable of growing the moment conditions for germination are favourable. Thus, wherever there has been a fire; wherever the soil is disturbed, whether in the high forest or in the sourveld surrounding it, keur seedlings make their appearance. The keur is found growing on inhospitable hills, on stony ridges, in dense masses where fires have occurred. On shallow soil and near the coast it occurs as a bushy shrub only a few feet high, but in favourable localities along the forest perimeter or within the forest, provided sufficient light is available, as a tree fifty feet high with straight boles up to two feet in diameter. Being a strong light-demander, the keur thickets soon begin to thin themselves, and in the favourable soil conditions which they produce the seeds of high forest trees find a congenial germinating bed, and in the friendly protection of the keur develop and take the place of the foster parent whose life is usually not much more than about 40 years, if as long. Numerous instances of the undoubted reclamation and extension of high forest brought about by keur are to be met with.

Since European occupation fires have become more frequent, owing to the common practice of burning the veld to obtain succulent vegetation for grazing purposes. The fires thus occur at intervals when the keur groups, resulting from former fires, have not yet emerged from the thicket stage, and consequently contain much dead wood not yet fallen or sufficiently decayed. Such groups succumb to the fires, but only to come up again in still larger numbers. This periodic destruction naturally interferes with the extension of forest, and, if continued unchecked by artificial means, the area of indigenous forests will be considerably reduced as a result of man's want of foresight.

Management of the High Forests.

The history of the management and utilization of the high forests does not differ materially from that of other countries.

As far as can be ascertained, the cutting of timber commenced about the year 1787, and with the increase of population the timber trade grew, and at the present time forms no inconsiderable part of the commerce of Knysna and T'Zitzikama. The indigenous timbers were and are extensively used, and it is, perhaps, no exaggeration to say that the high forests played an important part in opening up South Africa, for nearly all the wagons required in former years for transport were manufactured from local timber. For a long time, notwithstanding regulations, the forests were practically everyone's property, and, though licence fees were payable, more often than not the wood was cut without payment of the fees. Gradually, however, from the middle of last century, supervision became greater, and a large percentage of timber was licensed. The system followed was to permit licensees to select their own trees, and nearly all accessible parts of the forests were laid under contribution. Stinkwood (*Ocotea bullata*) was the wood most sought after.

In 1880 the Government appointed Count de Vasselot de Regné, a French Forest Officer of conspicuous ability, as Superintendent of Woods and Forests. With his appointment a scientific system of management was introduced. In 1883 Forest Regulations came into force, making a radical change in the management of the forests. The selection system was continued, but with this difference: instead of the woodcutter selecting trees, all trees to be offered for sale were selected over defined areas by the Forest officials, measured, numbered, and sold per cubic foot. As was to be expected, such a radical change was resented by the woodcutting community, but the Government persisted in adhering to the new system.

For some years after the introduction of the 1883 regulations the staff of the Forest Department was engaged in disposing of felled trees found scattered throughout the forests. Woodcutters, under the system practised formerly, frequently felled trees, and discovering some slight fault, discarded them, or perhaps only cut out the best portion, leaving the rest to decay in the forest.

As is to be expected, the woodcutter, permitted to make his own choice, naturally selected the best-grown trees; the faulty ones, or those too large or too small to suit his fancy, were not touched. It is also a fortunate thing that only a few species were in demand. To this and the extent of forest over which the selections were made is to be attributed the usually excellent state of the forests in regard to stocking and natural regeneration.

In a primeval forest containing a large number of species, only some of which are in demand, serious difficulties of management present themselves. Trees of all ages, of all species, are scattered more or less evenly through the forest, and when only certain species are taken the equilibrium of distribution is disturbed. In such a case a forester's main duty is to endeavour to dispose of faulty and mature trees only, reserving the most vigorous; to find a market for such species as are not in demand, and to do his best to foster a natural regeneration in the cut-over areas of the species most desired. Owing to limited funds in the earlier days, natural regeneration was left to take care of itself. Observation of many areas has shown that regeneration has, generally speaking, been excellent. The openings in the canopy made by the felling of trees have been taken possession of by a young growth, and, though interfered with by weeds for a time, has successfully stocked the areas. A singular feature is the abundance of stinkwood (*Ocotea bullata*). Not only do vigorous trees develop from the vegetative buds on stumps of the felled trees, but the admission of light enables an immediate response to be made by the numerous suppressed trees of the same species. Uusually the suppressed tree dies down to the ground, and from the collar a vigorous shoot starts, and in a great number of cases develops into a large tree. Other valuable species, such as *Curtesia faginia* and *Apodytes dimidiata,* are scarcely ever absent from the regeneration areas.

A disappointing feature is the non-response to increased growing space by some of the suppressed trees. The only explanation which occurs to the writer is that these trees, though small, are really of great age; have passed their period of height growth, and are only capable of crown development.

The selection system continues to be used, for under present conditions no other can very well be practised, because of the absence of a demand for fuel and light material, and the cost of transport to centres where a demand exists. In recent years a demand has arisen for many species hitherto not used, and if the demand continues the forest administration will be able to introduce a more intensive system of management, and combine the selection system with that of the group system.

During the past three years a more intensive system of management has been followed, with the object of maintaining the forests in their maximum producing capacity. A greater number of mature trees are marked for felling, and increased attention is given to the development of the reserved growing stock. Gaps, caused by felling operations, are planted up immediately. The tree to be used for this purpose was the subject of considerable study. In many places indgenous species soon make their appearance; in others, again, a weed growth covers the area and retards natural regeneration. It was observed that an exotic tree—the Blackwood (*Acacia melanoxylon*)—was capable of withstanding considerable shade; experiments were made, and gave results which warranted the use of the tree for planting or sowing in all places where weed growth was feared. Considerable areas of forest have been treated in this manner, and the success attained so far is most encouraging.

The Protection of Forest from Fire.

Manifestly it would be absurd to practise a system of intensive forestry within the forests if their very existenec was at stake by causes operating from without.

The danger of injury by fire, brought about by the custom of burning veld, makes it necessary to take precautions. While the keur tree renders good service, yet at stages of its growth it easily succumbs to fires; it was therefore necessary to devise other means. For many years it has been the practice to burn belts round the forests, but it is a question whether this practice is beneficial. At any rate, it does not give permanent protection, for the operation must be repeated every few years. Another method is to keep the perimeter free from inflammable material, and cause the fringe trees to develop dense foliage; the cost, however, of such a method is very great. Many pessimistic views were expressed to the effect that no adequate and economical method was attainable. A study, however, of the indigenous forest trees and the experiments made with exotic trees led to the selection of two species, namely, the blackwood (*Acacia melanoxylon*) and the blackwattle (*Acacia decurrens*), as trees suitable for planting along the forest perimeters. Both species have a strongly developed surface root system, thereby keeping the surface soil free from weeds; both are rapid growers and of economic importance—the former for its timber, the latter for its bark. The blackwood spreads rapidly from root suckers and coppices freely; both bear large quantities of seed. These two species were selected for planting along the perimeters of the forest, the *modus operandi* being as follows: From the forest perimeter is removed all dead wood and weeds; these are collected and burned along the forest edge at a distance sufficient to prevent injury; the cleaned surface is either picked over, or pitted, as circumstances dictate, and three or more rows of trees planted or sown—the blackwood is sometimes planted pure, sometimes mixed with black wattle. The young trees or seedlings are kept free from weed growth, and the following year another belt is planted, generally wider. In this manner the indigenous forests are protected, and at the same time the actual area of forest is increased. The results obtained have been most satisfactory.

In the three districts, during the past three years, the following perimeter planting has been done:—

T'Zitzikama	34 miles,	4	to	20	yards	wide.
,, ...	18 ,,	20	,,	100	,,	,,
,, ...	8 ,,	100	,,	300	,,	,,
Total	60 ,,					

Knysna	33	„	4 to 20 yards wide.
George..........	10	„	(about) 4 to 20 yards wide.
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Extension of Forestry Operations.

At the different Forest Stations, but more particularly at George and Concordia, artificial forests have been formed, in extent about 2,600 acres. Many species have been planted, and with few exceptions are in a thriving condition. The data yielded by this experimental planting is of great value, and enables forest officers to select species in accordance with the differing localities.

Within the George, Knysna and T'Zitzikama districts the Government owns 344,000 acres of land, of which 92,000 acres are high forest. 70,000 acres of land in the forest zone are capable of being planted with timber trees, and 182,000 acres are mountain land.

The indigenous forests are a valuable State asset, and, as already pointed out, have been supplying timber since about the year 1787. Every year the demand increases, and it is not to be expected that timber of large dimensions, which has taken many centuries to grow, can be supplied continuously except on a very long rotation. In modern forestry practice, trees of smaller dimensions are grown, and these may possibly not give the same quality as the primeval timber. In recent years many species which formerly were considered valueless are now much sought after, and possibly, when a railway is opened to Knysna, facilities will be afforded to dispose of forest products for which there is at present no demand. At any rate, if the indigenous forests are to be worked on a basis of a sustained yield, it is self-evident that a fixed quantity of timber only can be produced by the existing forests. The demand for timber is not likely to decrease in South Africa, and Nature having specially adapted the zone described in this paper for the growth of forest trees, it would seem that forestry extension on the many thousands of acres of available land is most desirable in the interests of the South African nation.

THE SERUM OR PRECIPITIN TEST FOR BLOOD, AND ITS PRACTICAL APPLICATION IN MEDICO-LEGAL CASES IN THE CAPE PROVINCE.

By John Muller, B.A., F.C.S.

In view of the number of criminal cases in which the precipitin test, whereby blood stains can be definitely distinguished, as originating from human beings or other mammals, has been successfully applied in this country and accepted as evidence in its law courts, an account of its origin, history, and local application may be of interest and value.

To be certain that a reacting substance is blood, it is still necessary, for forensic purposes, to utilize the ordinary tests for blood, such as that for hæmatin, etc., as the precipitin or biological method in blood diagnosis affords a means only of distinguishing the albumins of different animals, irrespective of their being contained in blood or in other products of the vital functions.

Deutsch,* of Buda-Pesth, claims priority in the suggestion of the use of artificial hæmolysins in medico-legal practice in the identification of bloods, both fresh and dried (9th August, 1900, and later).

The specific characters of precipitins were recognised by Ehrlich, who, in a paper read before the Royal Society in March, 1900, summarised the work done by Bordet, Fich, and Morgenroth on Lactosera.

Subsequently Wassermann (18th to 21st April, 1900) brought the question of specificity into greater prominence; he fully recognised the practical bearings of the discoveries of Tchistovitch and Bordet, and credit is due to him for having suggested the use of precipitins in the differentiation of albumins of different animals.

The medico-legal use of precipitins was almost simultaneously discovered by Uhlenhuth, Wassermann and Schütze† In February, 1901, Uhlenhuth for the first time published the results of experiments made under conditions likely to be met with in forensic practice, and indicated the value of the method in the identification of blood stains. A few days later Wassermann and Schütze reported having examined 23 specimens of blood, none of which reacted to anti-human serum except a sample of human blood and one from a baboon, the reaction in the latter case taking place much more slowly and to a lesser degree than in human blood. Uhlenhuth, in April of the same year, reported that his anti-human serum had served to identify human blood which had been dried three months, and that even blood which had undergone putrefactive changes for three months still reacted specifically to its antiserum.

In England Dr. Nuttall,‡ University Lecturer at Cambridge in Bacteriology and Preventive Medicine, has been the most dis-

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* *Centralblatt für Bakteriologie*, May 15, 1901.

† *Berlin Klin. Wochenschr.*, February 21st, 1901.

‡ *B. M. J.*, vol. II., 1901, p. 669: Nuttall's "Blood Immunity and Relationship," 1904.

tinguished exponent of the process,, and his recent work (published in 1904) on "Blood Immunity and Relationship" comprises a complete record of his investigations made in 1902 on certain blood-relationships amongst animals as indicated by 16,000 tests with precipitating antisera upon 900 specimens of blood from various sources. This work also includes a section dealing with the practical applications of the precipitin test for blood in medico-legal practice, together with some investigations carried out by Graham-Smith and Sanger.*

The principle of the test, as applied in medico-legal work, depends upon the fact that if into the body of any animal A the defribinated blood of another animal B is injected, after the lapse of a short time the blood of the animal A is found to be hæmolytic or toxic to blood of the species of the animal B.

The precipitin test was officially recommended by the Ministers of Justice in Germany and Austria in October, 1903, and as early as 1904 it had been used in the Courts of Law of France, Italy, Roumania, Turkey, Egypt, Ireland, and the United States of America.

England, with characteristic conservatism in matters touching her legal system, had not yet adopted it, this neglect being due, so the exponents of the test affirm, not so much to a distrust of the reliability of the new method, as to an ignorance of its existence.†

To the list of countries in which the test had been applied with success South Africa also was added in 1904,‡ for about the middle of that year the Government Veterinary Surgeon at Grahamstown afforded me every assistance in the preparation of various anti-sera, and we placed ourselves in direct communication with Dr. Nuttall, of Cambridge, whose advice was of very material assistance.

In a small town like Grahamstown it was extremely difficult at times to obtain human blood serum, so that at first the rabbits used as media (and the rabbit is *par excellence* the animal for this purpose) were given intraperitoneal injections of pleuritic and peritoneal exudations, hydrocele fluid, and albuminous urine preserved with chloroform instead of blood-serum injections. The anti-sera obtained in this manner appeared to be rather weak, and much less potent than that obtained by intravenous injections of blood-serum.

In the latter process blood serum is introduced by a fine-needled syringe into the marginal ear-vein in small quantities at certain intervals, and yields more powerful anti-sera, the human sera used for the purpose being chiefly derived from post-mortem cases, preserved by means of a small addition of chloroform, and kept in sealed tubes.

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* *Journal of Hygiene*, vol. III., 1903.

† See paper by Prof. McWeeney on "The Biological method of differentiating blood stains" in Report Brit. Ass. for Adv. of Sc., 1908, p. 882.

‡ Vide *South African Law Journal*, pt. I., vol. 24, pp. 4—12.

While these investigations at Grahamstown were in progress proceedings in the well-known murder case of Rex *vs.* Joseph Price, East London, were instituted, and exhibits in connection with that case were submitted to me, at Grahamstown, for the identification of the blood stains. Dried stains of blood known to be human (three from Europeans and one from a Hottentot), as well as stains of ox, sheep, pig, dog, rabbit and goat blood, were tested with anti-human and with anti-ox serum, prepared from rabbit blood in the Grahamstown Laboratory, and also with unprepared rabbit blood serum; the ox-blood stain yielded a marked reaction with the anti-ox sera, and the several human blood stains yielded equally marked reactions with the anti-human sera, but in no other case was any reaction produced The six stains supposed to be produced by the blood of the deceased were then tested with the various anti-sera, and reacted only with the anti-human sera, thus pointing to their being human blood. The conclusions deduced from the investigation may be better appreciated when put in tabular form:—

Material used.	Anti-human serum prepared from blood of		Anti-ox serum prepared from blood of		Serum from unprepared blood of
	Rabbit V.	Rabbit W	Rabbit X.	Rabbit Y.	Rabbit *Z*.
1. Fresh human serum	Marked reaction.	Marked reaction.	nil.	nil.	nil.
2. Human hydrocele fluid	Marked reaction.	Marked reaction.	nil.	nil.	nil.
3. Human (European) blood stain	Marked reaction.	Marked reaction	nil.	nil.	nil.
4. Human (Hottentot) blood stain	Marked reaction.	Marked reaction.	nil.	nil.	nil.
5. Ox blood stain ...	nil.	nil.	Marked reaction.	Marked reaction.	nil.
6. Pig blood stain ...	nil.	nil.	nil.	nil.	nil.
7. Sheep blood stain	nil.	nil.	nil.	nil.	nil.
8. Dog blood stain ...	nil.	nil.	nil.	nil.	nil.
9. Goat blood stain ...	nil.	nil.	nil.	nil.	nil.
10. Rabbit blood stain	nil.	nil.	nil.	nil.	nil.
11. Stain A	Marked reaction.	Marked reaction.	nil.	nil.	nil.
12. Stain B	Marked reaction	Marked reaction.	nil.	nil.	nil.
13. Stain C	Marked reaction.	Marked reaction.	nil.	nil.	nil.
14. Stain D	Marked reaction.	Marked reaction.	nil.	nil.	nil.
15. Stain E	Marked reaction.	Marked reaction	nil.	nil.	nil.
16. Stain F	Marked reaction.	Marked reaction.	nil.	nil.	nil.

The stains numbered 4 to 10 were each three weeks old at the time of testing. Out of several stains on the garments submitted for examination some were proved to be paint, and only the six included in the table (*viz.*, those marked A to F) were found by microscopic examination and the usual hæmin test to be *blood;* after this had been ascertained they were further tested by the precipitin test and found, as above stated, to be *human* blood.

It was at the East London Circuit Court in October, 1904, before Mr. Justice Kotze, Judge President of the Eastern Districts Court, that the above test for differentiating human from other mammalian blood was admitted for the first time in South Africa as authoritative. Unfortunately, the character of the stains was not of importance to the defence, and there was consequently no cross examination upon the point.

Very soon after this during the same year, I appeared in my official capacity as witness for the Crown in the case of Rex *vs.* Brichetti, an Italian stonemason tried on the charge of rape and murder before Mr. Justice Sheil, at the Butterworth Circuit Court. On application of the precipitin test, several human blood stains were discovered on the shirt and trousers of the accused. He explained these by saying that his finger had bled, etc.

In January, 1906, very clear conclusions were arrived at in testing certain exhibits in a murder case at Port Elizabeth.* A policeman had been murdered in a Kaffir location while in the execution of his duty, and a jacket, muffler, felt hat, belt, overcoat and two pairs of trousers, belonging to three of the Kaffirs arrested in connection with the crime, were submitted for examination. In all, thirty-two stains were found on the various articles of clothing, and it may serve a useful purpose to record here too that ten of the stains proved to be grease, rust, paint, etc., and twenty-two were ascertained to be *blood* stains; also that by means of the precipitin test twelve *human* blood stains were found on the jacket, hat, belt, one pair of trousers and overcoat.

The human blood stain found inside the crown of the felt hat was explained by the owner, one of the accused, that in expectorating from a bleeding tooth he spat by accident into his hat, which was lying at the time inverted on the floor of his room

The other accused, on whose trousers several human blood stains were found, stated that, in assisting an organ builder or tuner, he cut his finger in handling the metal pipes of the organ.

The third accused endeavoured to explain the blood stains on his jacket by saying that they had been derived from his connection with the butchering trade, and that in conveying the carcases of meat from the cart to the shop his jacket acquired

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* See Senior Analyst's Report (G. 53, 1907), page 30.

these stains. He evidently believed that it was impossible to identify the origin of blood in a stain on clothing.

During 1907 precipitin tests were applied to blood stains on five exhibits submitted in connection with a case* in which the accused was charged with the murder of a native woman who had been hacked to death. The exhibits comprised a hat, jacket, trousers, shawl, and axe found in the possession of the accused. Blood stains were found on all these articles except the shawl; of four on the jacket, three were proved to be human and one ox blood; of two on the trousers, one was ox blood and the other human; while two on the hat were both ox blood.

The accused alleged that he had been engaged in slaughtering an ox and accounted in that manner for the stains on his clothing. The blood on the axe was too minute in amount to test more definitely.

The case of Rex. *vs.* Klaas and Hendrik,† tried in Grahamstown at the Criminal Sessions before Judge President Kotze, in July, 1908, affords a very interesting instance of the application of this serum or precipitin test for differentiating mammalian blood. The prisoners were charged with malicious injury to property in having killed a heifer. The animal's intestines had been ruptured *per anum*, and a stick, the property of Klaas, was produced in evidence at the trial. It was stained with blood for about ten inches from one end, but had been rubbed in earth after being so stained. This prisoner had stated at the preliminary examination that he had killed a snake with the stick, and he adhered to this at the trial. The microscopic test clearly showed that the stains were not snake's blood, the corpuscles being round and non-nucleated, and the application of the serum test showed as clearly that the blood was that of a bovine. It is not surprising that Klaas, who no doubt thought his story of the snake a clever one, asked, "How can you distinguish the blood of a snake from that of a cow?" Both prisoners were convicted, largely upon the circumstantial evidence afforded by the stick.

During 1910 another important case from the Transkei was submitted to me. The accused, two natives, were charged with the murder of a little native girl at Mount Ayliff. It was alleged that she was hacked to pieces and the body terribly mutilated so as to obtain the blood, together with certain special parts of the flesh (ears, cheeks, etc.), for some witch doctor in order to assist him in his iniquitous profession.

In addition to the putrid mixture of blood, hairs, sand, starch, and other fibres made from the deceased's body, there were submitted also the following exhibits:—A, Large knife;

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* Report of Senior Analyst (G. 23, 1908), p. 108.

† Report of Senior Analyst (G. 31, 1909), p. 114; also *South African Law Journal*, 1908, vol. 25.

B, paper in which A was wrapped; C, small knife; D, brass rings; E, Kaffir sporran; F, blanket; G, cloth; H, old blanket; J. new blanket; K, leg rings.

To each of these articles a threefold test was applied: (1) Ordinary chemical tests, which would indicate whether any particular stain was blood at all or not; (2) microscopic examination, to show whether, if blood, it was mammalian or otherwise; (3) precipitin, to reveal, if mammalian blood, whether it was human or not. In the following summary, indicating the results of the tests, the several stains on each article examined are denoted by appended numbers::—

Article.	Chemical Examination.	Microscopic Examination.	Precipitin Test.	Conclusion.
A. 1	blood.	mammalian.	no reaction	not human blood.
A. 2	iron rust.	nil.	no reaction	iron rust.
A. 3	iron rust.	nil.	no reaction	iron rust.
B.	iron rust.	...	...	iron rust.
C. 1	blood.	mammalian.	marked reaction.	human blood.
C. 2	blood.	mammalian.	very marked reaction.	human blood.
C. 3	iron rust.	nil.	no reaction.	iron rust.
D.	negative.	...	...	no blood.
E.	doubtful.	...	fair reaction.	indefinite.
F. 1	negative.	...	...	no blood.
F. 2	negative.	...	...	no blood.
G.	negative.	negative.	faint reaction.	no blood.
H. 1	negative.	negative.	very faint reaction.	no blood.
H. 2	negative.	negative.	no reaction.	no blood.
H. 3	negative.	negative.	no reaction.	grease.
J. 1	negative.	negative.	faint reaction.	no blood.
J. 2	negative.	negative.	no reaction.	no blood.
J. 3	negative.	negative.	no reaction.	no blood.
K.	negative.	...	faint reaction.	no blood.

It was therefore concluded that the only article stained with human blood was the small clasp knife C.

The human anti-serum in this case was prepared by intraperitoneal injection with hydrocele fluid, and was duly tested with other mammalian bloods before being applied to the above stains.

During 1911 and the current year in no less than six other cases has this test been most successfully applied, and it is my firm opinion that by taking due precautions and arranging proper controls in the use of this test, there are but few conditions likely to be met with in forensic practice under which human blood could not readily be differentiated from other bloods.

The use of weak anti-sera, which require a period of about twenty-four hours to exert their action, should certainly be condemned for medico-legal work. Not only may many bloods react to an antiserum after such a lapse of time, but there is danger of bacterial development.

As normal blood dilutions possess an alkaline reaction, several observations have been made by Graham-Smith and Sanger* with various samples of leather which nearly always gave acid reactions on solution, chamois leather being alkaline, suède kid glove only slightly acid, and the coarser leathers very decidedly acid. It was found that nearly all the solutions of leather could be neutralised and the blood test satisfactorily employed. The thick polished yellow leather, however, forms an exception, as the solution is yellow in colour and extremely acid; the colour deepens on the addition of alkali. It is therefore impossible to obtain the specific test for blood from a stain allowed to dry on it. It is assumed that the mode of preparation of such leathers produces conditions which destroy the blood in contact with them. It is, however, just possible, under favourable conditions, when the blood has been thickly deposited on the surface, to scrape it off and obtain a positive reaction.

A series of experiments was also made to determine the effects of boot-blacking and polish. Blood stains blackened over were hard to detect on the boot, but by treatment (neutralisation and filtration) clear solutions could be obtained, and yielded well-marked reactions. Polish also made no difference to the test. Tannin saline solutions proved to have a very deleterious action on serum, rendering the application of the test, when it is present in large quantities, impossible.

There is just one more important fact to which I wish to refer: monkey blood gives similar reactions to human blood, though less strongly marked, upon the addition of anti-human serum, and it is possible that in some parts of South Africa cases may occur in which it would be necessary for the expert to prepare an anti-serum for the most prevalent genera or species of monkeys belonging to such a region in order to satisfy the Court of the presence or absence of monkey blood in the suspected blood-stains forming the exhibits in a criminal case.

In a series of experiments carried out on materials from Scotland Yard Museum by Graham-Smith and Sanger,† it was found that blood one year old on a hatchet, and also thirty

* Nuttall's "Blood Immunity and Relationship," p. 396; *Journal of Hygiene,* vol. 3, No. 2.

† Nuttall's Precipitin tests, 1904.

years old on a razor, gave, on the addition of human anti-serum, a marked colour in twenty minutes and three minutes respectively. Blood three years old on the lining of clothes gave a heavy cloud after sixty minutes, and blood-stained hair twenty-eight years old a similar cloud in five minutes. In each case the control anti-sera or normal sera gave no results.

Analytical Chemists' Association.—There has recently been established, with headquarters at Johannesburg, an institution for the purpose of encouraging the knowledge and study of analytical and industrial chemistry, and upholding the status and interests of the profession of technical chemistry, as well as for other kindred objects. For the present this institution, which is styled "The South African Association of Analytical Chemists," will confine its activities within the Union of South Africa, and will be independent of, and not affiliated to, any similar institution. The Council of the Institute of Chemistry of Great Britain and Ireland has expressed its sympathy with the objects of the new Association, and will be prepared, as far as possible, to support its endeavours on behalf of the profession. Although the headquarters of the Association have been fixed in Johannesburg, and therefore the principal officers have been selected from among gentlemen resident in that neighbourhood, the greatest care has been taken to make the Association fully representative of the whole Union, and the Union Government is being approached with a view to securing recognition of the Association as the official body representing Analytical and Applied Chemistry within the Union. The officers and Council of the Association are as follows: *President,* Dr. J. McCrae, F.I.C., Government Analyst, Johannesburg; *Vice-President,* Prof. G. H. Stanley, A.R.S.M., F.I.C., South African School of Mines, Johannesburg; *Hon. Treasurer,* A. Whitby, Consulting Analytical Chemist and Metallurgist, Johannesburg; *Hon. Secretary,* Jas. Gray, F.I.C., Analytical and Consulting Chemist, Johannesburg; *Council,* Prof. R. B. Denison, M.A., Ph.D., D.Sc. Natal University College, Maritzburg, J. S. Jamieson, F.I.C., Government Chemist, Durban, Dr. C. F. Juritz, M.A., F.I.C., Chief Chemist, Government Analytical Laboratory, Cape Town; Prof. R. Marloth, M.A., Ph.D., Analytical and Consulting Chemist, Cape Town, and Dr. J. Moir, M.A., F.C.S., Chemist to the Mines Department, Johannesburg.

Bushman Paintings in Southern Rhodesia.—In the June issue of the *Geographical Journal,* pp. 592-596, Mr. R. N. Hall describes briefly several caves with Bushman paintings in the Ma-Dobo range (incorrectly known as the Matopos), where he had recently discovered them during a six weeks' tour. Only six caves with paintings had been previously known, including the famous "World's View" cave. Of these six, only three had been even partially described. Mr. Hall has, he states, discovered thirty additional caves, together with fully one hundred sets of paintings on isolated rocks in the open. He declares that by these new discoveries the "World's View" paintings are far excelled, in number of objects portrayed, in their variety, in their size as heroic pictures, in the number of different colours introduced in depicting one object, and in the higher conception, greater skill, freedom, and artistic taste in the majority of cases. The animals include elephants, giraffes, rhinoceroses, lions, antelopes, and snakes, some of which are eight to ten feet long, some of them in five colours. The trees include knobby thorns, baobabs, umbrella trees, palms, tree-ferns, euphorbias, Kaffir orange, aloes, wind blown trees, and monkey ropes, as well as aerial and exposed roots. The human form is seen in every attitude and all forms of action. In four cases there were representations of the Victoria Falls, one of them being six by four feet.

TRANSACTIONS OF SOCIETIES.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, August 17th: W. R. Dowling, M.I.M.M., President, in the chair.—"Minor improvements in cyanide practice": P. T. **Morrisby.** The author described a variety of improved appliances and small devices for overcoming minor difficulties introduced in the working of the Witwatersrand Mine.—"Investigation of magnetically separated iron from mill pulp": A. McA. **Johnston.** Attention was called to the various ways in which iron in the tube mill circuit affected working disadvantageously and lessened efficiency, interfering with amalgamation and with recrushing in the tube mills. Magnetic separators had been installed and the iron withdrawn by them examined, the author stating that, when removed from the pulp, this product may be easily oxidised by exposure to the atmosphere, wetting and turning over, and that, failing any better means of disposal, this oxidised product, if fed into the circuit, will yield an average percentage of its gold to amalgamation and cyaniding.

Geological Society of South Africa.—Monday, August 19th: Dr. E. T. Mellor, F.G.S., Vice-President, in the chair.—"A contribution to the structural geology of the East Rand": H. L. **Krause.** The author broadly indicated the direction of strike and angle of dip of the Witwatersrand strata exposed on the East Rand, and then proceeded to discuss the main theories that had been put forward with regard to the stratigraphical position of the Rietfontein Beds.—"The volcanic rocks of the Pilandsberg": Dr. W. A. **Humphrey.** The rocks forming the Pilandsberg are the denuded remnants of what was once a stupendous volcano, comparable in size with the greatest of present-day active volcanoes. The height of the peak was probably about 16,400 feet above its base. The rocks forming the mountain group may be divided into two main classes:

(1) nepheline syenites and phonolites, (2) alkali syenites and trachytes. The rocks are probably considerably younger than any of the sedimentaries of the Waterberg formation.

South African Institution of Engineers.—Saturday, September 14th: Mr. J. A. Yule, President, in the chair.—"Electric hoists in headgears": S. E. **Boult.** The author considered the subject of winding mainly from the point of view of the cost of installing and maintaining electric hoisting plant and the ease of control, with a view to prevent overwinds and to secure even winding.

Cape Chemical Society.—Friday, August 30th: Dr. C. F. Juritz, M.A., F.I.C., President, in the chair.—"Thoric dioxide in South African monazites": Prof. P. D. **Hahn.** The author gave an account of the occurrence of monazite at Embabaan, Swaziland, and at Houtenbeck, Transvaal, the former of which contained 6.66 per cent., and the latter 3.23 per cent. of thoric dioxide. In both cases the monazite was strongly radioactive, and this was also the case with two specimens of euxenite from the Transvaal, which contained respectively 1.54 and 2.04 per cent. of uranic oxide.—"Seasonal variations in composition of Cape Peninsula and Kimberley milks": Dr. C. F. **Juritz.** Results of analyses of 4,755 milks from the Cape Peninsula and of 812 from Kimberley, extending over the last seven years, were tabulated in monthly, quarterly, and yearly series. The range between the minimum and maximum monthly means was considerably more at Kimberley than in the Peninsula. Fat was at a maximum in both localities simultaneously, but solids-not-fat at different periods of the year. At both places the fat was at a maximum at the beginning of the cold season, *i.e.*, contemporaneously, while the solids-not-fat was highest at the commencement of the rainy season, which did not synchronise for the two places.—"Agricultural soils from La Dauphine, French Hoek": Prof. B. de St. J. **van der Riet.** The results of analyses of six soils from the Paarl Division were stated and discussed. These soils were from fertilised vineyards, and derived principally from the Table Mountain sandstone formation.

NEW BOOKS.

Colvin, Ian D.—*The Cape of Adventure: being the strange and notable discoveries, perils, shipwrecks, battles upon sea an land, with pleasant and interesting observations upon the country and the natives of the Cape of Good Hope.* 8vo., pp. xxxv, 459. Map and Illus. London: T. C. & E. C. Jack. 1912. 10s. 6d.

Stevenson-Hamilton, J.—*Animal Life in Africa.* 8vo. (9½ in. × 6 in.), pp. xvii, 539. Illus. London: W. Heinemann. 1912. 40 oz. 18s.

Young, T.—*Short history of South Africa and its people for the use of schools.* 8vo., pp. 223. Maps. Cape Town: T. Maskew Miller. 14 oz.

Knox, A.—*The climate of the continent of Africa.* pp. xiv, 552. Illus. Cambridge University Press. 1911. 21s.

Moubray, J. M.—*In South Central Africa: being an account of some of the experiences and journeys of the author during a stay of six years in that country.* 9 in. × 5½ in., pp. xvi, 198. Map and Illus. London: Constable & Co., 1912. 10s. 6d. nett.

THE TRADITION OF RA'LOLO.

By Rev. Johannes August Winter.

Introduction.

Ra'lolo (pronounced Rachlolo) is one of the greatest Indunas of the present paramount chief Sekukuni II. He is a man of about 50, I should say, iron gray, slender, with an intelligent face, and of very quiet manners. He is the son of old Selai, who used to be called, by his own wish, Satan, mothsubabatho (the burner of men). This Selai was the most intimate friend of old Sekukuni I. When the latter, while still a young prince, was banished from the capital by his father Sekwati, because of his misconduct with one of his father's wives, the young Selai went with him. They always hunted together. On the very night of Sekwati's death both hurried in the dark to the capital, and, before anyone knew of it, Sekukuni took possession of the chieftainship against his rival Mampuru. In January, 1880, when I came to establish a Mission Station alongside the capital, then recently burnt down by Sir Garnet Wolseley, I went to a little kraal in the mountain to tell the chief there: "Do not be afraid if you see a strange fire in the plain; it is mine." I found in the expression of face of this chief a very sad dignity, not often seen in any man. I saw, squatting on a stump, a bald-headed, oldish-looking chief—with just the face you see in pictures of Mephisto—above the ears on both sides little bushes of hair like small horns. I was told it was old Satan, the man who urged on Sekukuni to kill the Christians, at the time of the martyrdom of our oldest Bapedi Christians. I had with me one of the best of all Native Christian men, old Johannes Maeli, of Botsabelo, of Maleo's tribe, one amongst ten thousand, 50 years old, a man of no bigoted or hypocritical ways, but a sober, practical Christian, who was always greeted by the Mapoch warriors, "*Sagobona mabule*" (greeting, opener), because when the others were afraid to fire the first shot at the Boers before their home, he was the first to shoot. This man was known by hearsay to old Satan, who loved all brave men. Both started chatting. I shall never forget how Maeli told Satan what Christianity meant. He said (looking down on the ruins of the old capital): "Where is the capital? The capital is, where all **difoka* are brought together."

This word interested old Satan, and wishing to hear more, he actually accompanied us down the hill. Both his wives were amongst the first I baptised, and strangely, both loved each other without jealousy! Once the younger complained that

* "Difoka" is their war-flag, a stick covered with black ostrich feathers borne alongside the chief when marching, always waved up and down.

Satan had thrashed her. I sent for him, and told him: "You were quite right" (because she, when going to church, always left her young child alone to old Satan's care). He never came to church, but yet to the end we were good friends. Ra'lolo is his son. When Mr. Hunt sent Ra'lolo to me to assist me in writing the old Bapedi history I told him of the many tales I had heard of the cannibals,* *e.g.*, that they fattened their captives like cattle, and, when they intended to kill them, made them hold up their arms above the head like horns of cattle. Ra'lolo would have nothing of this, and said that these were mostly fictions; he would tell me only sober, historic facts. Ra'lolo is still living at Sekukuni's capital: he and one other being the only two men who were against Sekukuni allowing the Lutheran Bapedis to build a church there. Nevertheless, I like the man.

RA'LOLO'S STATEMENT.

I was born at Phiring (Magalie's), and am about 50 years old. Our Kgoro is called Mapitsing. My father's name was Selai, or Kgoloko.† Our family (Kgoro) is connected with Tulare, the famous old King of the Bapedi. Tulare's father—Moroamotshe—was also the father of Kgoloko, my great grandfather (Kgoloko, Puthi ea throkas, Selai).

First I shall tell you what the old man told me, when young; then what I myself have seen. In the oldest times we were at a place called Mapogote or Malakoaneng (a place still called so by the Basuto), not far from Moshesh, Basutoland (source of Vaal River?), in the Highveld, as the name Malakoaneng shows (which means "amongst the sugarbush"). At that time no rumour of a white face had been heard of. We left there, not after a fight, but were probably tired of the land. The name of our oldest known Chief at that time was Motshetabane. Then we and the Bakgatla were still one tribe. We settled at Marapazane (Schildpadfontein), district Pretoria, near Warmbad, Waterberg.

When Motshe was an old man we left there. We were driven away by the Bakgatla. They said: "*Lea re lolela*" (you bewitch us). Our old great-grandmother—Matebele—most beloved wife of Motshe, was the cause of jealousy with the other wives and their childen. They first made mocking songs about Matebele, saying, "Her child cried, when still in her mother's womb." So this child's name was called "Le Lellateng" (you cry inside). They tried to kill this child. We then left them. The Bakgatla, from the other greater sons of Motshe, were then our superiors, which later changed. Even now, when someone greets us "*Dumela Mokgatla*" we respond. The name Bapedi we took from the country now called Sekukuni's, Bopedi.

* Not so long ago a middle-aged woman told me she was compelled to eat the roasted arm of her uncle.

† His name during the persecutions of the first Christians at Mosego.

Our Chief, under whom we left, was Tobele. He was still young. We were very many, and very rich in cattle, sheep, and goats. We crossed the Olifant's River at Mola'legi's (where President Burgers had his fight against Sekukuni), below the junction of the Elands and Olifants Rivers. This country was then ruled by the tribe Mongatana. The name of their then Chief I do not know.* To the east of the Lolu Mountain at that time were found the tribes of Masemula (Magalie) with that of Matlala (Pokwani), or Pahla, or Mmopong (Passoane's tribe, where now is Kgolane's kraal). All of them had come from the Swazis. We crossed the Lolu Mountain at the Pass of Mo'laki (Genokakop). Before this we were ba-bina-kgabo (the ape being our tribe's holy sign). When we came down the Lolu Pass at the place called Seolo-mathebo (a big anthill covered all over with long stripes of kweek-grass like the many floskels of a kaross—it is still there) we found a porcupine bristle, and from then commenced being ba-bine-nuku. We then commenced our most solemn tribe-song, still used at great national festivals: It is this:—

Re bua Mo'laki, Mo'laka-Marole,
Mo'loping oa Masebutla-Sadimo-
Seola-Mathebo
Oa naka dira le magodu
Mabije-Maramage
E kago mae a Tshiloane
Re Bamookotsi oa Kotongoane
Adimaloo-'Labioa-
Re Ba'laku ba Rapogole.

When our impis come home victorious, they are greeted with this song. Also when the cattle for marrying enter the kraal of the father-in-law, throughout Bopedi. Our Chiefs then had no hymn upon their names, it being not the custom of the Bakgatla. This we commenced here, when we became a big tribe.

We crossed Steelpoort and built our kraal across the river at the Mogokgoma tree.† We found on this side of the river a kraal, called the Maripane, a kraal left by the Baroa when they came from Swaziland. These brought us to the capital of the land, to Fighting Hill, the Mongatane. At the time we knew nothing of guns. We fought with assegais only, and hatchets and kiris of rhinoceros horn. The Mongatana, being Baroka, fought with bows and arrows. Before we came they had fought the Mapalakata, the old miners from the East Coast, who

* It was Mashabele.

† A tree like a weeping-willow, very scarce, with iron hard wood, not touched by ants, and bearing a little sweet yellow fruit, which, fresh and dried, was the chief fruit of old Sekukuni at Fighting Hill, where there are still a few of these trees.

had very long thin rifles and had killed them all, at a place where the Magakala now live, keeping these guns, which were always shown at their big festivals and danced round. We believe them to have been Arabs with red fezzes. The Malepa—who are still found here—with Mohammedan religious laws, might have been left by them and intermarried. The son of Tobele was Kabu. There was no war all this time. We paid our tribute in thatching grass and building-poles; we paid no other taxes. The sons of Kabu were Tobele and Tobejane. Tobele made use of his father's wives, when not yet circumcised—not yet a man. So the nation grumbled and mocked him. He went with his friends to the cattle-kraal, where the young girls brought the ground Kaffir-corn for porridge. One day he left with these girls and all the cattle, and fled away. We do not know where his tribe is now—perhaps at the Victoria Falls. He had many followers, also the Ba-Ramapulana (Batsuetla, ba-Makgato—against whom the South African Republic had its last Native war in Zoutpansberg). These Batsuetlas were then of our tribe, but later changed even their language.

Tobele being, in fact, the Chief, we did not follow him to fight, but remained with his younger brother Tobejane. It was a peaceful rule, without wars. We still greet each other after him: *Dumela moroa oa Tobejane.* His son was Moukangoe. Both Tobejane (his name of praise: Tobejane *oa* Botobele) and Moukangoe (his name of honour): Moukangoe *oa diala tse Tobele*) had hymns upon their names. Moukangoe lived very long, and became so old that the wrinkles of his forehead covered his eyes*. He was much beloved by his people. Our taxes from that time till to-day to our Chiefs were: the right-side-ribs of an ox, and of grain a leselo of Kaffir-corn. It was not compulsory to bring him beer. Those who brought these got something killed for them. It was a voluntary sign of loyalty. Moukangoe was very rich in cattle, not taken from other tribes, but peacefully bred in that splendid grazing country, although the country was full of big game, and sometimes the tsetse killed many. When very old he went no more to the Kgoro, the council-fire-place before or at the entrance to the cattle-kraal, round which our huts were built. His eldest son was Lesailane (Passoane), who soon died, without leaving any children. The second son, Mohube, was already acting Chief, when the old Chief grew too old. One day Mohube went to the cattle-kraal. His young men then killed a piece of game. A Bakone tribe, ba-Gakomana (now on De Kom, Lulu Mountains), whose kraal was near Mohube's cattle-kraal, quarrelled about this game, claiming it as theirs. They killed our young men and Mohube, but did not take the cattle. The Gakomana went quickly to headquarters at Fighting Hill, to

* He therefore had his skin tied up by a bandage, so that he could see a little.

tell the Paramount Chief their deed of bravery, having killed a Chief, bringing the shield, arms and beads of Mohube there. Our young men waylaid these messengers and killed them at the Steelpoort Drift (Fort Burgers). One of the enemy escaped and went to the Paramount Chief at Fighting Hill, to complain. We also had already sent to complain, but the ba-Mongatana only laughed at our Chief being killed. The ba-Mongatana sent a big Impi, because their old subjects had been killed. It crossed the Steelpoort. The fight began near our home. It was daylight, and the fight lasted only a short time. We got the best of it. We did not follow them to their home, but took many of their cattle-herds. We turned back from the Monpetsi River (Clapham). Our Chief now was Mampuru, the third son of Moukangoe, who was still alive. This Mampuru was the Chief from whom the Magakale tribe came. Then we went and attacked the Ba-Gakomane. The man who had killed Mohube was killed by Sethabalake, of the Kgoro Bogopa. Those of the Gakomana who were left, and had fled far away, later sent a girl as peace-offering, and built again near their old kraal. The Mongatana sent as peace-offering the son of the Paramount Chief, Magosi. Mampuru gave this man his daughter Nthane as a wife. Both went home to Fighting Hill, and there was peace. Mampuru regarded himself only as acting Chief, and brought up Moroamotshe, Mohube's son, as real heir, together with his own son Nthobeng. These two were Mampuru's fighting generals in all his expeditions, which were many. There was a Chief Mamaile (on Groot Hoek), who, although in some way of the same race as ba-Mongatana, made himself independent of both, the Maroteng (Sekukuni's tribe) and the Mongatana. Against him Mampuru sent his first Impi. He himself went with his son and nephew. Mamaile in his stronghold (even now a landmark) was, however, too much for Mampuru. He had to return unsuccessful. Then Manoamagoadi, a man of Mampuru's, went to Mamaile, telling him that the cattle of ba-Maila (a tribe at the Western base of the Lola Mountain, *ba-bine-tlou*) were near by at Suale (Maandags Hoek). Mamaile went with his men to take them. Mampuru was in ambush on his road, waiting for him. When Mamaile came, Mampuru killed him and burnt his kraal, and took his people with him.

Then Mampuru went to Mmopong, to fight the ba-Manganeng. He was very successful in this raid. The rest of that tribe, their Chief being Mangane, gave a girl to Mampuru as peace-offering. Then Mampuru went to attack the Bakoni on the other side of Lydenburg. But the stronghold had only one entrance, which was successfully defended by the enemy. A man of the Bakoni from whom his people had taken his wife, went out of the stronghold in the night, to Mampuru, and promised him to show him a feasible entrance to the stronghold and the cattle within. Mampuru ordered his son Ntobeng to go and fetch this cattle. Ntobeng refused, saying, "the stronghold is too strong." Then he sent Moroamotshe. He agreed to go. So Mampuru gave him the Makoa (the young men circumcised with Moroamotshe- and the Mokoni as guide. The guide brought them behind the stronghold to a big tree (*Moumo--Ficus elastica?*), the branches of which always have strong air-roots, and are easily climbed. Then they went up to the top of a big rock with little precipices all around. They thus entered the stronghold without being seen. At sunrise Mampuru again commenced the fight at the front entrance, and Moroamotshe from behind. So they captured the Bakoni Chief Nsuanyana. Mampuru praised now Moroamotshe and mocked the cowardice of his son Ntobeng. When he arrived home, he called Moroamotshe and Ntobeng. Then he gave to both young men a string of the famous Chiefs' beads (old heirlooms of the Chiefs; nobody at the present day knows where they came from, one string even now being very valuable*) and ivory arm-rings, cut from elephant tusks. He gave, however, his own son Ntobeng two rings, and to Moroamotshe only one. Now Moukangoe, who was still alive, called the young men, to look after their adornments. When he found that Moroamotshe got less than Ntobeng, he called for a stone, broke Ntobeng's ivory arm-band, and said: "I will give you more than that." Calling together all the many cattle-herds of the whole tribe, he ordered them each to bring a young ox and heifer, and then gave them all to Moroamotshe, Ntobeng getting nothing. This was our first cause of quarrel with those of Magakal, who afterwards left and fought us. Mampuru and Moroamotshe after that were never good friends again.

Moukangoe now died, and was buried by Mampuru. When in the summer Mampuru's sons were marrying, and big festivals and dancings were plentiful, Moroamotshe did not dress as he ought to have done, but purposely annoyed Mampuru by wearing an old cured cattle-hide. The *Indunas* complained to Mampuru of the proud behaviour of Moroamotshe. So Mampuru called him and dressed him in fine garments, but notwithstanding, the next day Moroamotshe again wore that old bad skin. Mampuru again called him, and dressed him with beautiful strings of beads. Then a man, Makoropane, of the Kgoro of Pala, said to Mampuru: "The boy has grown; give him the kraal, and make him Chief." But another *Induna*, Mokgabudi, of Bogopa's Kgoro, said: "How can we make this child a Chief; when his father (Mohube) had never been a Chief?" † Makurupane answered: "Are you afraid that he will not give Mampuru of the cattle he may get by fighting?" Now Moroamotshe went

* They have three different colours of these strange beads: green, yellow and black.

† He was killed before he could become a chief.

with all the cattle of the Moshatte to a cattle-kraal not far from home. A Mokoni, having no food, went to the kraal, begging milk. Moroamotshe gave him milk, but said: "Do not go out with me to the pasture of the cattle, you are still too weak from hunger." Later he went out with him into the field, to look after the cattle. In the field he said: "Chief, take off from me my skin-blanket." Moroamotshe said: "Take them off yourself." When he had taken off his dress, he showed to Moroamotshe, between his shoulders, a bag full of beads, and gave them to Moroamotshe. He sent them to Mampuru. Mampuru thanked him gratefully, and sent them to his house. The messenger of Moroamotshe, on his return, told him that Mampuru thanked him, but has sent the beads to his own house, not to Moroamotshe's. He became angry, and this caused again great unfriendliness between Mampuru and Moroamotshe.

Moroamotshe now fled away with the cattle and his young men. Mampuru followed him with an Impi, because he had also taken cattle belonging to his children. They fought. Moroamotshe got the better. Mampuru's men, when flying, threw down even their assegais. Mampuru went a second time to fight him. During the fight Mampuru was wounded by a Chief of the tribe of Manganeng, who also was wounded by Mampuru. Moroamotshe got Mampuru into his hands as prisoner, but did not kill him. Instead of that, he nursed him and cured him. The Chief who was wounded by Mampuru grew worse, and his people demanded from Moroamotshe that he should deliver him into their hands to kill him, so that both might die. But Moroamotshe refused to do this The Chief of Nkoane in the night advised Mampuru to fly, and to build a kraal of his own in some kloof. Mampuru agreed, and when not yet quite recovered, fled to his kraal, and from there with his people to the hill Suale. Moroamotshe would not follow him. He said: "Let him live quietly; he is my father." At this time Moroamotshe had built his new kraal higher up the river (where now the farm Goudmijn is). Mampuru was nevertheless uneasy so near by, and went farther beyond Pasha's near Nkoana's Kraal. From there he went again farther away to Magalie (Masemula). To all these moves Moroamotshe consented. But when Mampuru wished to go across the Olifant River to Bokgatla (Waterberg District), Moroamotshe refused. Afterwards Mampuru returned and settled at the Kloof Malokelo.* While he was there, Moroamotshe died. Mampuru sent his men to assist at the burial. The sons of Moroamotshe were Dikotope, Tulare and Motodi. Mampuru was on friendly terms with Tulare, and invited him to visit him. He went. Mampuru now advised Tulare to fight

* Now Putney where their old stone-walls are still to be seen. The throne of Mampuru was made of Kudu horns at the back, and his seat was of Buffalo-horns on which nobody was allowed to sit except himself.

his elder brother Dikotope while he (Mampuru) was still alive. He also asked Tulare to bury him (Mampuru), after his death, at their head kraal, alongside Moroamotshe.

Dikotope wished to go back to their old home at the Mogokgoma-tree, lower down Steelpoort. Tulare said to him: "Go on, I shall follow you later." So Dikotope went, but Tulare remained. One day the cattle-herds, incited by Tulare, drove all the cattle from Dikotope, when they were out grazing, to Tulare. Dikotope was afraid to attack Tulare. The latter formed an *Impi,* and went to kill Dikotope, who fled away with his people to near Ohrigstad. When there he secretly arranged an expedition against Tulare, joined by the Bakoni and the Ba-Mongatana, who were still sore at heart at having lost their Paramountcy. Tulare heard of this. He went on with a strong *impi* to prevent the two *impis* of the enemy from joining. He went down Steelpoort, near the old kraal of the Bapedi, and waited there for the ba-Mongatana. These came too early, before Dikotope had arrived. The ba-Mongatana (with ba-Pasha and ba-Nkoana) camped on this side of Steelpoort, opposite Tulare on the other side. Early in the morning, when the ba-Mongatana were still smoking dagga, Tulare's men attacked them, gained a splendid victory, followed them up to the Moupetsi river, took large numbers of their cattle, and then went back to attack Dikotope's kraal, while the latter was still away forming his Bakoni *impi.* The kraal was empty. Tulare's force waited there for Dikotope to come. He came, but his auxiliaries were still behind. They fought. Tulare again had the victory. Dikotope was killed, as also the Chief of Maëpa (the Bakoni), Mo'labini. Now Tulare went home, the real undisputed Paramount Chief of the country. He became the greatest and, till to-day, the most renowned Chief of the Bapedi.

Mampuru, when afraid of Dikotope, fled out from Malokelo (Putney) into the mountains near Olifants River. The old Chief went into a big cave, which is still to be seen, and is still called: *Leoa* (because it is a precipice) *la mokgalabye* (the old man's cave). Even now, when Natives on this hill are digging for Letsuku*—even now, before they take out this stuff, they still pray to this old Chief in his cave, saying: "Allow us to take out our Letsuka; we have not come as enemies, but as your children."

He is said to have lived seven years in this nearly inaccessible cave.†

Subsequently, Mampuru returned to Malokelo. When very old, and he no longer actually ruled, one of his sons, Nkoana, was acting Chief, another son, Molamosu, was near him.

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* The yellow slate, which when burnt gives them their red ochre colour, which when mixed with butter is used to colour their skins and in their opinion beautifies them.

† I once camped inside it.

He sent for Tulare. Although Tulare's *Indunas* advised him not to go—lest he should be murdered—he went out in the night, with three men only, dressed in an humble-looking kaross, with a cap made of cattle-skin. When he arrived it was still dark. Nobody there knew of his having come. The old Chief was very glad to see him, and said: "Be not afraid, my son Molamosu is only a mouse." Early in the morning Mampuru dressed him in his jackal's kaross, with his hat of jackal's-skin, and told him to go to the council-place and to sit down on his (Mampuru's) throne of buffalo-horns. Meantime all the men were called to this place by the old man. When the men arrived they found Tulare sitting on Mampuru's throne. Molamoso rose and told the men: "Greet the Chief there." All said: "Morena, Morena!" He only answered with the usual "Age!" and after a little while went back to Mampuru's house. Mampuru said to Tulare: "When I am dead—even when buried—exhume my body, bring me to our old home and bury me there My son, if my people steal your cattle, don't kill them. Kill them, if they have killed somebody." Then Tulare went home. Not many days after a man from Magakel came to tell him: "Mampuru is dead; we have buried him."* Tulare went with many men, exhumed him, and took him to their old home at the Mogokgoma-tree, where he buried him.

The Magakal men were angry, and went out with a strong commando, and burnt many little kraals of Tulare's people at the lower Steelpoort. Tulare, with his *impi*, went round the Mount Moroni, and came upon them from behind. Tulare camped at the tree. Magakal's men, from this side Steelpoort, crossed the river to attack Tulare. They fought. Very soon Tulare drove them back and followed them, but not to their home. His instructions were not to kill all of Mampuru's children. All the big Chiefs and *Indunas* were killed, except Molamoso (the least amongst them) and Mogase. These were caught and hidden away during the fight, so that Tulare's men might not kill them, not knowing them. No guard was left with them. Later, both came out and went home. Tulare sent his men to take the cattle. Molamoso, with all his people and his many auxiliaries from the Baroka, fled across Olifants River, and settled at the Mo'lapitsi River, where, only during the last year, 1900, the greater part crossed back, and now are settled at Surbiton. They did not ask for peace from Tulare, and he no more molests them because of old Mampuru.

Now the Matebele tribe of Zebediela, with Mapahlele, made an arrangement in secret with Magakal to this effect: "Tulare is too great for us at his home. Let us go and deceive him, telling him that there are many herds of cattle far away in Zoutpansberg—and when he is there, all tribes together fall upon him and kill him."

* The Natives bury at once after death has taken place.

Tulare heard of this, and straightway went to attack Zebediela with a big army, but allowed that tribe to believe that he was not out against them, but for the cattle that they talked of. At first he passed their kraal, but, when on the other side, he sent word to call them to show him those herds. When Moletlane's men came, he ordered all the young men of his and their army to a certain distant camp, and as soon as they had left, he fell, with his men, upon the men of Moletlane and killed them all. The young men of Moletlane, hearing of this, fled away. Tulare did not burn their kraal. He did not even take all the goods, nor all the cattle, from the old woman-chief, mother of the dead Chief Lekoba. Tulare went home rich in cattle.

Shortly after, Tulare made his greatest expedition, up Steelpoort, passing the Mapoch's, Maleoskop, far into the Waterberg and Zoutpansberg District, up to Ganana (Blauwberg), and back over the Draken Mountains. The whole mass of Natives of Transvaal, afraid to fight, asked for peace, and gave tribute, except Moletake (north of Pietersburg).

When back at home, he said: "The whole world I have conquered. There is only one single man, near me, whom I cannot conquer, Modimo (God)." A time of great peace now ensued, as far as Vaal River, and further.

Wherever there was trouble, he sent his sons, and no longer went personally. He was never cruel, and gave many presents. His numerous cattle-herds covered the country from the Lolu to the Komati River. In his judgments he was impartial. His wives were innumerable. His chief sons were: Malekut, Matsebe, Pethedi, Sekwati, Makopole, Makgeru and Sebas.

Behind his house there was a hill, which is still pointed out, and which nobody, no *Induna*, no child nor woman, was allowed to step on. He reserved this hill for himself alone.

Regarding the period, we can only estimate it by this: Tulare's fourth son, Sekwati, died in 1861, an old man. Allowing him to have been 90 to 100 years of age, would bring us back to about 1761 as the time of Tulare.

Sometimes his *Indunas* and people in the morning were astonished to find strange tracks (horses') at the back of Tulare's huts, round his famout Witgat (Mo'lope) tree.

Many times his son, Makgeru, was reported to be sick, and was not seen for a long time. He was secretly sent to the white men at the sea coast, and brought back from there many useful things.

As Tulare grew old he saw, with great pain, the jealousy amongst his sons. Once he is said to have told them: "This great capital will one day become a wilderness. The ostrich will lay its eggs under this Mo'lope tree, and the rhinoceros will rub itself against it."

He loved his son Makgeru best of all, and impressed on his eldest son Malekut always to take care of him after his death. Tulare died peacefully in old age.

The next Chief was Malekut. He made a fighting expedition as far as Rustenburg. When he returned he brought back a great many herds of cattle. Soon he became sick. Makgeru went to see him. He said: "When you die, Matsebe (the next heir) will kill me; you had better fight with him at once." This was the first root of the fall and decadence of the mighty Bapedi rule. Malekut agreed to this advice of Makgeru.

Nearly all men liked Matsebe, but not Malekut. They wished Malekut to die. One night all the men with Matsebe went out of the kraal. One man went at the same time to steal some of the Chief's grass-bundles, which were standing against a tree, outside the kraal. He listened, and heard their secret talk. Makgeru was present at this secret conference; and said: "I protest against your plans against Malekut. I am on his side; better kill me, if you wish to kill him." The hidden thief under the grass now went and told Malekut all, also that Makgeru alone was against their plan to kill him. Makgeru also went and confirmed all, saying: "If you do not do what I advised you, I alone shall be the enemy of them all. Motodi now left Matsebe and went over to Makgeru. Malekut died. Matsebe refused to bury Malekut, took his weapons, and, with his party, went out to prevent the others from burying him. Notwithstanding, the others buried Malekut. Matsebe now left altogether, with all his party and cattle, crossed Steelpoort, and camped at Mapodile (Winterveld). The war-horns were now sounded across from the home-kraal. They came on and fought. They killed Matsebe's younger brother Rampelane, and gained a complete victory. Matsebe fled up a rock. Motodi cried out: "Let him alone, he will ask for peace." But as soon as they had left him, he fled farther away to Magakal. From there his men always came back in the night and murdered everyone they could find. Now Pethedi went, with a strong force, to attack Matsebe across Olifants River. Magakal's and Matsebe's men fled into the Draken Mountain, behind Magakal. In the night they returned to kill Pethedi's men, when asleep. First they came to Pasha's men. The other part of the camp, being awakened by the noise, now ran to assist Pasha's men, and soon drove them all away into the mountains. They then burnt Magakal's kraal and took their cattle. A second attack was made by Magakal. They tried to draw Pethedi's *impi* into a narrow kloof, hoping that their large numbers would then be of no avail to them. But again they were defeated. Matsebe was killed. Pethedi now invited the ba-Magakal to come down and make peace, which they did.

After they left, the ba-Magakal went out to attack the ba-

Mongatana. Just when Pethedi's *impi* to assist the ba-Mongatana were out, a messenger arrived, saying: "Makopole is flying out to join the Bakoni." The ba-Magakal did not fight with the ba-Mongatana, but only took their cattle and went home. Makapole was now as the Chief of the Bakoni (Tshianyana) round Lydenberg. Pethedi went there with his *impi*. But the stronghold was too much for him. So he returned home. Some time after the Zulus, under Mosilikatse, came and killed Makopole, the other side of Lydenburg. When a part of the Zulus came to Krugersrust, Pethedi went and killed them. Some of these Zulus crossed the Olifants River and went into the low-bush-field (now Portuguese). Gunganyane was their Chief.

Now, the greater part of the Zulus under Mosilikatse came down Watervall. They divided their forces. Our *Impi* came over the hills to the right of Dwars River, the other through the nek (*sefata sa Ngoaneng*, Olifants Nek). Pethedi's young men went to attack the latter. When they were away, the war-cry was heard from the hills behind. Pethedi with his men went against them. He and all the sons of Tulare were then killed in a fierce fight except Sekwati. Pethedi's only fell, being full of wounds, after a very brave fight. The young men did not find the enemy and returned home. In the afternoon the Zulus arrived and found that the women and children had fled up the Lolu. So they only burned the kraal. This was the end of the rule of the Bapedi in Sekukuni's land. The Zulus now settled down on both sides of Steelpoort. All Basutos had left their kraal and fled far away. Now all the Basutos of all tribes from Magalie to the west of Lolu made a big *Impi* together. They came down the long kloof from Schoonoord to Steelpoort (Waterval), and killed all Zulus round about. These were only *Impis* of Mosilikatse. He himself was still behind. The very day the Basuto killed these Zulus here, Mosilikatse himself came with his chief regiments. He killed all the victorious Basutos and finished them. That was the final end of all Bapedis and Baroas. Sekwati was on the Lolu (at the Honoko-cave) that day. He fled into the Zoutpansberg district. A few of the Bapedis and Basutos lived in the caves of the Lolu. Many a day they spied from the mountain, where the little Zulu herds let the cattle go astray, and came down and stole and ate a great many of them.* That kept them alive, as they did not dare to make gardens. The Zulus also had no grain and lived upon their enormous herds of cattle, sheep and goats. Mosilikatse only stayed for one year. Some of the Bapedi and other went with him, when he left. They also became Zulus, and had their earlobes perforated like them. From here Mosilikatse went to near Pretoria, from where later

* One of them is said to have cut off, fried and eaten the tail of a live sheep.

the Boers (Paul Kruger as a young boy) drove him northwards.*

After the Zulus left, came the awful time of the cannibals. The first Chief who, with his people, commenced to use human flesh as food was Monaoe, a Chief of the Batsoako, near Ohrigstad. They did it from hunger at first, all their grain and stock having been taken by the Zulus. They followed those few single men and families, which lived dispersed in kloofs and caves. They caught first the Chiefs of the ba-Gakomana, but did not eat them, but took their kraal and compelled them to live with them and to feed upon men like them. They trained their dogs to follow the spoors and footsteps of men. After again making gardens, they continued to hunt men, because they liked the meat. One day they had a *letshima* (a numerous party to weed a garden) and got the fancy to kill a man of Gakomane out of their number and to eat him. The ba-Gakomana refused to allow this. It came to a fight, and the ba-Gakomane killed these makgema (cannibals), but they continued to hunt men and eat them; they ate the very cannibals, who first taught them. None of the other tribes asked for peace, being afraid of being eaten. One day they surrounded the ba-Mongatane round Fighting Hill, when they came down from the caves to make their garden. The Chief—Passoane—was a very fat man, and although in the pot for a long time, would not become done. Another day they went over the Lolu and caught Lekgolane, daughter of Tulare, sister of Malekut.† They brought her down to Fighting Hill. They did not kill her, but released her, saying, "She is also a great and fat Chief, and will not be done by cooking like Passoane, who even was a lesser Chief: let her go and make up another kraal of people for us." Then there rose up a certain Marangang from the Bakoni. He was no Chief, but became a great Chief by his valour and prudence. He tried to kill out the cannibals with an *Impi*. But they fled into a certain great cave near Ohrigstad, and although he made a big fire at the mouth of it, could not manage to kill them. After Marangang left, the cannibals made their kraal inside a big thicket of trees and shrubs. Now Kabu, son of Makgeru, who was then near Magnet Hights—went with another *Impi* to destroy them. It was summer time. They saw one of the cannibals in the gardens, who had not yet seen them. They sent four men to kill him. One of the four, Sethokgoa, stabbed the cannibal, who also wounded him; the other three fled away. Then the other cannibals saw the *impi*, and, leaving their kraals, fled into the thick bush. But Kabu's men caught some women,

* It may be of interest to say that the late President Paul Kruger one day sent a message through the writer to Sekukuni's people saying: "We Boers found you living in kloofs aud caves, being woodcutters and watercarriers for Mosilikatse, from whom we delivered you. Why do you now quarrel with us?"

†This Lekgolane was the mother of Kogolakai, chief wife of Sekukuni.

and made them prisoners. The cannibals now sent two girls with many valuable beads to ask for peace. Kabu told them: Yes, on the condition that they were to cease eating men. This was the end of the cannibalism.

Marangang ruled them all until Sekwati came back from Zoutpansberg. There he had been growing rich, powerful, and renowned. His son, Sekukuni, then a baby, was with him there.

Transvaal Grass for Paper-making.—Experiments conducted at the Imperial Institute with a species of *Aristidia* from the Transvaal have shown it to be inferior to Esparto grass as a paper-making material, yielding, as it does, less pulp, and being of shorter fibre. On this account paper made from it was brittle, lacking in flexibility, and generally of poor quality. It was suggested that the grass might be converted into pulp for local use, but for this technical trials on a manufacturing scale were needed.

Antarctic Names.—In the *Bulletin of the American Geographical Society* (vol. 44, No. 8), E. S. Balch remarks on the fact that Antarctic explorers, when giving names to their new discoveries, have been apt to bestow on the latter the names of leading political personages, each of his own nation, instead of, as one would have thought, turning to their principal geographers and scientists. The writer commends the idea of remedying the over-indulgence in royal names by shortening such names as King Edward VII Land and Kaiser Wilhelm Land into Edward Land and Wilhelm Land. For the great area of land discovered by Amundsen he presses the suggestion previously made by him, that it should be known as Amundsen Land, and for the South Polar ice-cap he is content with the name Haakon Plateau for the time being, but continues in hope that geographers will ultimately decide that Amundsen Plateau will be an improvement. For the coast of South Victoria Land, which was sighted by Lieutenant Pennell in the *Terra Nova,* the writer of the article puts forward the name Pennell Land: this is coupled with the suggestion that the coast discovered by Shackelton, to the west of Cape North, be called Shackelton Land. Ross Island, he thinks, ought to be re-named, and so Hooker Island is recommended. The name King Edward VII Plateau, given by Shackelton to the ice-cap south of Victoria Land, should be restricted to that portion of the cap which is situated between Victoria Land and Haakon Plateau. It might well be shortened into Edward Plateau, or, preferably, altered into Shackelton Plateau. The plateau as a whole, it is considered by the writer, needs no special name, as it will inevitably be spoken of as the Great Ice Cap of Antarctica.

NOTE ON FLORAL PERSISTENCE UNDER SPECIAL CONDITIONS.

By Rev. Frederick Charles Kolbe, B.A., D.D.

There is nothing strange or unexpected in forms of life remaining substantially the same for long periods, provided the environment remains unchanged. But here and there, owing to denudation or other causes, a whole environment may gradually dwindle away. It is interesting then to watch the fleeting succession of frail plants telling the same story as the permanent rocks around.

For instance, just near the entrance of Tulbagh Kloof there are some masses of rock called Bushmen's Rocks. One of these masses is about 100 yards in length and not many feet high. It is all that remains of a spur of the neighbouring Table Mountain Sandstone range. It is completely surrounded by the clay-slate formation of the Malmesbury Beds. Perhaps it is not large enough to be called a *maesa*, but it might be used as an illustration of that physical phenomenon. Now, of course, the rocks alone tell the story plainly enough of how denudation first isolated and at length minimised the mountain down to a tiny plateau. But even if we knew nothing of the rocks, the plants would tell the same tale equally well. The little *maesa* abounds in plants whose congeners are sought for in vain in the clay around, but are found again in the mountains over the way. Unfortunately I have not had the opportunity to make a list of these plants but *Lachenalias, Albucas,* and an *Asclepiad* straggler recur to my memory. The general impression, however, was to me vivid and immediate, and ever since I have promised myself the pleasure of a special collection there.

A similar phenomenon displayed itself to me a year or two ago at Cala. The hills near this beautiful town are undergoing a very rapid denudation—so much so that I know no place in South Africa where that process can be better demonstrated in all its varieties. The rocks there are, I suppose, of the Karoo Beds; at any rate, they have the characteristic frequent in those Beds of alternating layers of hard sandstone with soft shale. The result is that the merry little river there is busily engaged in scooping out krantzes which it presently abandons, leaving them high and dry in successive stages up the mountain-side, telling where once the waters found resistance. Most of these krantzes have trickling over their surface and into their crevices the overflow of the moisture of the soft spongy slopes that intervene. Hence the environment has remained sufficiently alike to enable plants to corroborate the story of the rocks. Along the rocks of the stream to-day there are forms of *Streptocarpus, Crassula, Alepidea* and other genera, which are not to be found at any distance from the water. Now these same plants are still found on those krantzes which the stream abandoned centuries ago. They have their crevices, their shade, their sheltered ledges, and the trickle of the sponge-ooze deludes them into the fancy that they are still bordering their beloved rivulet. Again, I had not sufficient time to make a detailed list, but I jot down this little note to direct attention to an interesting line of study, which must find many opportunities in our mountain regions. This may even be a partial solution of the problem of the very narrow limits within which many of our plants occur.

ELECTRICALLY PROPELLED VESSELS.—From one of the United States Navy Yards there was recently launched the collier *Jupiter*, which, when completed, will be the first sea-going vessel to be driven by electricity. She will have twin screws, which are to be driven by a pair of induction motors receiving their energy from a variable-speed turbo-generator. The *Jupiter* is stated to be the largest vessel ever built on the Pacific Coast, and is 572 feet in length.

RUBBER FROM RHODESIA.—A reddish-brown rubber from North-Western Rhodesia, known as Chimeya rubber, and believed to be derived from a vine, has recently been examined in the laboratories of the Imperial Institute. The rubber was in excellent condition, and possessed very satisfactory physical properties. It was valued at 4s. 9d. to 5s. per lb., with fine hard Para being quoted at 6s. 11d. Analysis of the dry, washed rubber showed it to be of very good quality, as it contained 91.5 per cent. of caoutchouc, and only .6 per cent. of protein, although the ash was rather high in amount, namely, 1.3 per cent. It included a considerable amount of vegetable impurity, which, it was considered, could be reduced by exercising more care in collection.

AVOGADRO PREMIUM.—The Royal Academy of Science of Turin has resolved to devote the balance of the amount subscribed in memory of Avogadro to a premium for a chemical work, having some bearing on Avogadro's Law. The premium, which will be of the value of £1,500, or take the form of a gold medal, if desired, will be awarded to the candidate who in the three years 1912-1914 shall have published the best work on chemistry, either of an experimental or historical critical nature, having some bearing on Avogadro's Law. The works entered will not be returned, and must be written in Italian, French, German, or English, and at least three printed copies must be sent in before the end of 1914, on the last day of which year the competition will be closed. The premium will be awarded in 1915.

BARTHOLOMIEU DIAS'S FURTHEST EAST.

By Prof. Ernest H. L. Schwarz, A.R.C.S., F.G.S.

Some two years ago an iron-bound box, filled with the remains of documents, and bits of a devotional image were unearthed at the Kowie. The place was near a well that had been dug on what was then Mr. William Cock's property; it is now called St. Mary's Cove, and is on the west bank of the Kowie. Mrs. Irving, Mr. Cock's daughter, informs me that the well was dug by a party of soldiers who camped near it in about 1823; it was the custom in those days for the soldiers to be sent out to help in reaping the harvest in the early days of the settlement. According to Mrs. Irving, the cove was named Mary's Cove after her sister, and the "Saint" was added subsequently; it is, however, just possible that an image of the Virgin was dug up by the soldiers, who then christened the place St. Mary's Cove, and that the bracket recently found formed part of it. The papers in the box were too thoroughly sodden with water to be of any use, and, unfortunately, they were thrown away without proper examination.

The importance of the find lies in the fact that De Barros relates that Bartholomieu Dias landed at the Penedo das Fontes the Fountain Rocks. The passage is obscure, as he identifies the Penedo das Fontes with the St. Croix Islands, but Perestrello, who made a survey of the coast in 1575, immediately after Dias's voyage, puts the Fountain Rocks off the Kowie, and the rocks there bear this name to the present day. Pacheco, in his "Esmeraldo de Situ Orbis," which is the source from which De Barros obtained his information, further states that the Penedo das Fontes is the tallest of the Ilheos da Cruz. After leaving St. Croix Island Dias passed the "Ilheos Chaos" (Low Islands), and set up a pillar at or near a sandy cliff identified with Cape Padrone. Pacheco mentions the Ilheos Chaos in considerable detail as occurring between the Penedo das Fontes and the Rio do Infante, and gives their distance from the latter as fifteen leagues (51 miles). This would seem to identify them with Bird Island and the rocks near it. He further states that between these islets and the Rio do Infante there are the mouths of three small rivers, possibly the Bushman, Kariega, and Salt Vlei Rivers. If the Bird Islands are the Ilheos Chaos, 51 miles brings us just midway between the Kowie and the Great Fish River, and the presumption is that the distance would be over-estimated rather than under-estimated, so that there is a possibility that the Kowie is the original Rio Infante. Duarte Pacheco was a contemporary of Dias, and himself made a voyage to India and back before 1505, so that he would be in a position to gather information on the points visited by Dias. He definitely states that the pillar set up by Dias at St. Croix Island had a cross on top—"*Bartholomieu Dias pôs aly hum padram de* *pedia pouco mais alto que hum hanem com hua cruz em cima"*—and at the same time he is positive that the Penedo das Fontes is merely another name for this islet. In this point, however, Pacheco is in conflict with Perestrello, who actually surveyed the coast, whereas Pacheco merely skirted the coast in the course of the voyage to India, and I am inclined to harden on the point that the Penedo das Fontes of Dias is the Fountain Rocks of the Kowie.

In regard to the River Infante, most authors identify this with the Fish River. Perestrello says that the Rio Infante is five *legoas* (17 miles) east of the Penedo das Fontes, which is the distance of the Fish River from the Fountain Rocks at the Kowie. Theal accepts this identification, as does Major in his "Life of Prince Henry," and also Ravenstein in his "Voyages of Cao and Dias."* De Barros states that it is 25 leagues (85 miles) from St. Croix, which would place it more nearly at the Buffalo River. After setting up the Cross at St. Croix, the crews of Dias's ships refused to go any further. After a long parley, it was agreed that they should sail three days eastwards, but no more. At the end of this time the ships anchored off a *small* river, which was called the Rio Infante, because Joao Infante, captain of Dias's companion ship, the *Sao Pantaleao,* was the first to land.

The whole difficulty of the identification of the points in Dias's voyage lies in the fact that imperfect data have to be squeezed into accurate maps. How much confusion may be caused by this is illustrated in Captain Riou's map of Van Reenen's journey to the wreck of the *Grosvenor*. The site of the wreck, which is near St. John's, Pondoland, is placed just south of Delagoa Bay. Bartholomieu Dias was on an exploring expedition in an unknown sea; the crews were half mutinous, and great trouble was encountered with regard to bad food and stormy weather, and the Commander was half distracted. In addition, Dias had completely lost his bearings, for it was only on his return journey that he discovered the Cabo Tormentoso, now the Cape of Good Hope; he had sailed south below the Cape and then eastwards, endeavourng to find land, and had struck the coast at Cape Vacca, near Mossel Bay. Under these circumstances, distances would not be accurately computed. Perestrello, coming soon afterwards, was engaged in a definite survey, and could go about his work in a more leisurely way, and also he was working on a coast which was already known The very fact that he was employed so soon afterwards shows that Dias's positions must have been unsatisfactory. Pacheco was going to India, and no means were available to establish points with any accuracy, for the ship had to hurry on as fast as possible.

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* *Geographical Journal,* December, 1900.

My own reading of the three accounts is that Bartholomieu Dias landed at St. Croix, and then sailed three days to the east, to the Penedo das Fontes. Here he landed, took his boats up the river to St. Mary's Cove, where there was a spring at the place where the well now is, watered his ships, and left a box of documents relating to his voyage, together with an emblem of Christianity, to mark, as it were, the farthest limit of the Faith in this unknown country.

Why Pacheco, and after him De Barros, confused St. Croix with the Penedo das Fontes is that here also a cross was erected. This is only surmise, but it explains the mysterious cross which is supposed to have been set up at Cape Padrone; it seems unlikely that these storm-tossed ships should have anchored off an open coast, and have taken on shore a great stone pillar just after having done the same at St. Croix, which is only 35 miles distant. At the Penedo das Fontes, the Kowie Fountain Rocks, there is a good ship's channel between the rocks and the coast, and the rocks form a natural breakwater off the mouth of the river as it then existed (it has since been diverted about a mile to the west). De Barros says very plainly that a cross was set up on an islet half a league (a mile and a half) from the shore, and that it was called the Penedo das Fontes. This is the actual distance of the Fountain Rocks from the shore, whereas St. Croix is two and a half miles from the shore. The cross was set up on an islet, but that islet was St. Croix, which was wrongly identified with the Penedo das Fontes. At the Penedo das Fontes, as I take it, the rocks off the mouth of the Kowie River, the Rio Infante, and the turning-point of the expedition, the explorers wished to place a cross on the mainland. Hence they selected a position on a "sandy cliff," which I would identify with the great sand-dunes above St. Mary's Cove, and this I would make the place of the cross supposed to have been erected at Cape Padrone. As a matter of fact, these sand-dunes are now used for the same purpose, and a pillar has been erected there for the guidance of shipping, the Glendower Tower, which goes to show that the position is a very marked one from the sea. The fact that Dias called the Fountain Rocks the Penedo das Fontes, the Rock of the Fountains, indicates that he anchored here and watered his ships. The river in those days reached the sea just opposite the rocks, and then turned westwards parallel with the coast, the channel being separated from the sea by a ridge of low dunes. After about a mile, the river then came up against the west bank, where the fountains were (the present well at St. Mary's Cove), and then turned inland. No more suitable place could have existed for watering the ships, and the heavy stone cross could have been comfortably off-loaded into the boats as the ships lay under the lee of the Fountain Rocks, and could have been landed in the calm waters of the lagoon. To have tried to land a heavy stone in boats in the surf off the open shore of Cape Padrone would have been madness. At the Kowie, too, both on the east bank as well as the west, there are lofty sand cliffs, which would have made admirable places on which to erect a cross, and when erected, it would have formed a conspicuous object from the sea.

The tale of the Portuguese establishing a slaving station at the Kowie subsequently is usually ascribed to an imaginative story that was published in Grocott's *Penny Mail*. The tale is discredited, as the Kaffirs only came into the country long subsequently, but at the time of the Portuguese, in the early part of the sixteenth and seventeenth centuries, the country was inhabited by Bushmen; indeed, the country between the Bushman's River and the Great Fish River was the last stronghold of the Bushmen in the eastern districts; it is quite possible, therefore, that the Portuguese, knowing from Dias that there was a watering-place at the Penedo das Fontes, did establish a slaving station here, and caught the Bushmen. Local tradition states that the old Custom House, whose ruins can still be seen on the east bank just above the old mouth of the river, was built on the site of an old Portuguese fort. I have myself obtained Bushman pottery in the kitchen midden just behind it. I can find no account of a slaving station so low down in any accounts of the east coast of South Africa, though they were plentiful further up, and a great trade existed in slaves between the east coast of Africa and India.

In regard to the name Kowie, it is from the Kaffir word *Ikowa*, the Sabbath. In reality it is a Bushman word taken over by the Kaffirs. Although all the east coast districts are now inhabited by Kaffirs, the area occupied by the Bushmen in former days is clearly defined by the names of places, especially the rivers. All the rivers in the Bushman country have clicks in their names, such as the Kareiga, Kowie, Keiskama, Kei, Kologha, and so on. North of Umtata all the rivers have pure Kaffir names, and the old Kaffir had not the Bushman clicks; hence the names are soft— Umzimvubu, Umzimhlava, Umtamvuna, Umzimkulu, and so forth. It is quite possible, therefore, that the name Kowie has something to do with the devotional image, part of which was dug up recently at St. Mary's Cove.

As far as one can sift the accounts, then, the Kowie is the Rio Infante, and Bartholomieu Dias anchored his ships under the lee of the Fountain Rocks, took his boats up to St. Mary's Cove for water, and, as this was his furthest east, selected one of the highest sand cliffs to erect his last stone cross.

A photograph of the Kowie angel, as the devotional image is called locally, was published recently in the *Geographical Journal*. Dr. Scot Keltie, however, before publishing my letter accompanying the photograph, asked Mr. Edward Heawood to look up the facts from the Portuguese records, and I am very greatly obliged to Mr. Heawood for so kindly sending me details, especially of Duarte Pacheco's account, as his "Esmeraldo de situ Orbis" is not available in South Africa. Joao de Barros's and Manuel de Mesquita Perestrello's accounts are, however, given both in the original and in translation in Dr. Theal's "Records of South-Eastern Africa."

Lime Cartridges for Shattering Rocks—Letters patent have recently been issued in England for a lime cartridge to be used for breaking down coal, rocks, and other minerals. The cartridge comprises a metal tube, which is hermetically sealed and is packed with granules of quicklime. Inside of this tube is another, which is perforated and fitted with a non-return valve, through which water can be forced into contact with the lime. The tube is capable of withstanding a pressure of about 2,000 lb. per square inch, and produces a large shattering effect upon bursting in a borehole.

Gale's Comet.—On the 19th September Mr. W. F. Gale, of New South Wales, discovered a new comet, *1912a*, near θ Centauri. It was of the sixth magnitude, and was travelling northward and eastward. After traversing in succession the constellations Hydra, Libra, and Serpens, it crossed the constellation Hercules during the early part of November, grazing the eastern boundary of Corona. On the 13th September a photograph of the comet taken by Mr. H. E. Wood at the Union Observatory, Johannesburg, showed a tail of about four degrees in length, with a shorter tail, one degree long, and inclined to the other at a considerable angle. The comet had no stellar nucleus, but merely a central condensation.

The Oxygraph.—In a recent issue of *The Engineering Record*, this appliance, which operates on the principle of the Pantagraph, is described. Unlike the latter instrument, however, it is not hand-driven, but is propelled by means of an electric motor, attached to the head of the instrument. Moreover, it does not enlarge or reduce the original drawing in pencil on paper, but cuts it into three-inch steel by means of an oxy-acetylene torch, at a speed of six inches per minute, and is capable of cutting curves and right-angled corners. The mechanically propelled tracer moves at a uniform speed along the lines of the pattern on the tracer table, a reproduction of the design being meanwhile cut in the steel by the torch.

FARMING BY DYNAMITE.

By William Cullen, M.I.M.M.

This question has recently aroused a great deal of interest in South Africa, and the newspapers have recorded quite a number of demonstrations which have been given by the different manufacturers of explosives. The idea is not new by any means, and has been practised for quite a number of years in England and to a lesser extent on the Continent, but it is in the United States of America that the greatest development has taken place. Indeed, one might safely say that the idea is almost exclusively American, so general has the use of dynamite become in farming operations there. Some six or seven years ago the writer, who had been watching events on the other side, tried to interest the Transvaal Agricultural Department in the question, but receiving no encouragement, he let it drop. The very general interest now being taken is evidence of the fact that South African agriculture is endeavouring to keep pace with the times, and although no one can dogmatise at this stage, some one or two fairly definite conclusions have already been reached. These will be referred to presently. When the Union legislators were in the Transvaal towards the end of last year, Sir Meiring Beck, in responding to a toast at one of the official functions, stated that there was more potential wealth in the first 12 inches of South African soil than in all the mines, and he was right. "Farming by dynamite," as it has now come to be called, enables one, however, to go down much lower than 12 inches. But what is the use of this? one may well ask. Well, the answer is very simple. Most arable lands ultimately develop what is called a "hardpan" The plough, as a rule, does not get down further than 10 inches—seldom so much. True, by deep ploughing it is possible to get down 15 to 16 inches, but after all this is only comparatively deep, and even then the so-called hardpan is ultimately formed. In most cases this becomes almost waterproof, and prevents rain soaking into the ground. As a consequence it also prevents roots getting down; therefore the area from which they draw their nourishment becomes limited. If anyone cares to take the trouble to drive a crowbar, or jumper as it is called out here, by means of a hammer into land which has been ploughed for a succession of years, it will be found that the first 9 to 12 inches is easily traversed, but as soon as this small distance is passed the jumper goes down with ever-increasing difficulty, showing that a new stratum has been struck. This is called hardpan—an American term, if I am not mistaken—and it is quite easy to understand how it is formed. Once this hardpan is opened up by dynamite or any other means, the rain soaks in, an immense reservoir of stored-up water is formed, and the roots seek their way downwards instead of extending laterally. The soil also becomes aerated, which is a very necessary condition for healthy plant growth.

Now we have no South African experience to go on yet, and it will be many years before we have, but our American friends, from whom I am in the main quoting, speak of the beneficial effect of breaking up the hardpan with the greatest assurance. They have applied it to practically all kinds of agricultural and horticultural products, such as maize, cotton, fruit and tobacco, and although the initial operations may be, and no doubt are, expensive, they are positive that the results repay the expenditure many fold. I could quote numberless cases which bear this out, but the actual proof is found in the fact that dynamite for this particular branch of work forms a very large proportion of the output of many American explosive factories. The truth is that dynamite would not be used in such large quantities unless it gave a good return; our American cousins are cute enough for that. Perhaps one of the most interesting developments in connection with its use is the "toning-up" of ground on which fruit trees or cotton plants have been growing. It happens sometimes that year by year the yield of fruit or cotton has fallen off, and the plants seem limp and lifeless. Something very similar to hardpan is generally found to be the cause. Charges of dynamite placed at judicious intervals between the rows have loosened the soil below, and given the plants a new lease of life. If care is taken in placing the holes, the roots need not be damaged at all; indeed, if the charge is placed properly, all that happens when the explosion takes place is that a dull thud is heard, and the soil is seen to rise a few inches, only to subside immediately. If one opens it up, however, the effect about three to four feet down is very considerable. The soil all round is loosened and fissured, but the effect really extends much further than mere digging indicates. As I have already said, results prove this.

Our American friends use the term of "ploughing by dynamite" very frequently, but this is really a misnomer, because in every case ploughing and harrowing have to follow on the breaking up. Supposing it is desired to break up either old land with hardpan, or virgin veld, holes are made in the ground about 2 feet 6 inches to 3 feet 6 inches deep, and at about 12 feet apart. When the charge explodes very little disturbance of the surface takes place, but, as in the "toning-up" process, which I have described, the effect below is very great indeed. No person can yet dogmatise as to the depth of holes or their distance from one another, nor yet as to the charge of dynamite which should be used. Experience is the sole guide, and every case must be considered on its merits. For a light loamy soil, however, anything from 50 to 100 lbs. of explosive per acre will be required. For the hard shales of the Cape lucerne lands much more would be necessary, but I am only speaking of them from hearsay. In any case lucerne land, which is worth, as I learn it is, from £200 to £400 per acre, could easily stand from £5 to £10 on dynamite if it can be proved, as I believe it can, that a commensurate increase in cropping will result. With regard to staple crops, however, we must await definite results, and already there are a great many experiments in hand, even with mealies, the results of which will be duly recorded. Of course, if "dynamiting" had to be done every year few crops could stand the expense, but American experience shows that once every five or six years is quite sufficient, and from what I have seen I can well believe this to be the case. There are, however, two applications of dynamite to farming and afforestation about which I can speak with a very considerable amount of assurance. The first is the removal of tree stumps, and the second is the planting of trees.

The removal of stumps is always a troublesome and expensive process, and when the tree has been a deep-rooted one it is intensified. In many cases, rather than go to the expense of removing them farmers simply leave them in the ground. Dynamite will get out a stump at a fraction of the ordinary cost, and if it be not too large—not more, say, than 18 inches diameter—one charge will be sufficient. If the stump is a very large one, more than one charge, placed at different points, may be necessary, and when this is so, it is best to do the blasting by electricity, as by that means both charges, and, indeed, any number up to 50, explode simultaneously, which naturally gives the best effects. With experience it is possible to blast even the largest stumps with a single charge, but here again one cannot dogmatise, and if a large number of stumps have to be removed, it will always be found cheapest in the long run to get advice from an expert.

The second application of dynamite about which one can speak with a measure of assurance is the planting of trees. There is no doubt whatever that one of the most crying needs of this country is afforestation—more crying, perhaps, than that of the raising of crops. I need not here speak of the climatic influences of afforestation, as they are now generally recognized. Dynamite will certainly further afforestation by cheapening planting. In the same way it will cheapen the making of orchards, for no matter how difficult the soil, dynamite will make a hole big enough for a good-sized fruit tree at very little cost. But even though it does cost as much to make the hole by dynamite as by the ordinary process of digging and trenching, the ultimate result is not so good by the latter as by the former, for, as already explained, dynamite opens and cracks the ground underneath to a very considerable depth. By this means plant growth and yields are increased, so our American friends say, and one can well understand that this is so. Limiting ourselves, however, for the moment to the economics of making holes for trees, we have already sufficient South African experience to indicate that "dynamiting" is cheaper than the ordinary process.

There are many other possible applications of dynamite to farming which will all come in time. For instance, in the Transvaal, I have seen some most excellent trenches or ditches made on farms in vlei and other land. Then, again, draining land by the ordinary perforated pipes is a very costly process—so costly, indeed, that it is seldom done in South Africa. Breaking through the practically waterproof stratum with dynamite is just as effective, and much cheaper. Here, again, however, we shall have to await results before any general scheme can be outlined.

This is not the place to describe how the various simple operations of preparing the charge, making the holes and then charging them, are carried out. Any person of ordinary intelligence can learn all that has to be learned in a very short time, and if common sense is used, there need not be the slightest danger to any operators.

Some may be curious as to the kind of dynamite which is used for these operations, but there is really no great secret about it. It is what is called a "slow explosive," *i.e.*, slow in exerting its explosive effects. The composition which my company recommends is one which contains 35 to 40 per cent. nitro-glycerine, the balance being made up of nitrates and wood pulp. The quicker and stronger explosives, such as blasting gelatine, and the old kieselguhr dynamite which was formerly used in the Kimberley mines, would be quite useless for the processes which have been described. In most cases they would only make a little crevice at the botom of the bore-hole, and would certainly not give the heaving and rending effects which are necessary. They, too, however, have their application in the removal of boulders and the making of roads and cuttings, but these operations are just a little outside the scope of these notes—which have been written with the sole object of arousing interest.

BIPHOSPHATE.—Under this name a new fertiliser is being prepared at the Notodden Nitrate Works in Norway, by dissolving raw phosphates, such as Apatite, in nitric acid prepared from the nitrogen of the atmosphere. The *Chemical Trade Journal* states that a sample of biphosphate, analysed on arrival in London, contained 26 per cent. of phosphoric acid and 23.9 per cent. of calcium nitrate.

POISONING BY PINE-APPLES.—Toxic symptoms following upon the eating of pine-apples are reported from the hospital at Hanoi, Indo-China, where cases of such poisoning have been admitted. The actual cause of the poisoning is involved in mystery. By some it is attributed directly to some constituent of the fruit, while others believe that the poisonous properties have been induced by the fruit having been bitten by some venomous reptile or other animal. The action of the poison is on the nervous system, and results in heart failure, with cyanosis and purple patches on the skin. Serious and even fatal consequences have ensued, collapse following upon coma. As an antidote a hot infusion of pine-apple bark appears to have been successfully employed.

BERGSON'S CONCEPTION OF TIME.

By Rev. Sidney Read Welch, B.A., D.D., Ph.D.

The issue of at least two popular expositions of the philosophy of Henri Bergson is a curious phenomenon which throws considerable light upon the peculiar mentality of what we may call the "average reader" of to-day. It is barely thirty years since Bergson began to expound his recondite system of the universe, and it was natural enough that so many brilliant suggestions as he has made should provide mental pabulum for those accustomed to consider problems of philosophy.

But how can we explain the interest of the general public? The comfortable word Evolution may have something to do with it. But Bergson is also a master of the homely metaphor, and considers it the choicest instrument of philosophic thought.

"Many different images, taken from different orders of things, can by their convergence direct consciousness on the exact point where there is an intuition to grasp."

Figures of speech can certainly do all this, and more, where the mind has been trained and the habit of intuition, if I may say so, has been cultivated; but with the reader of popular books the only possible result must be a variegated series of brilliant light-effects, which can hardly leave any definite image behind.

In all Bergson's works, of which *Creative Evolution* is the most complete, the constant appeal to the facts of science is another source of popularity. This appeal, however, is combined with the boldest flights of philosophical speculation from a starting-point that is within the apprehension of all. But in this connection two warnings are necessary for the general reader.

First, Bergson is not always careful to state clearly which are the facts of science and which are the results of his own vigorous effort of introspection. Take as a flagrant instance the opening sentences of *Creative Evolution*.

"The history of the evolution of life, incomplete as it yet is, already reveals to us how the intellect has been formed, by an uninterrupted progress, along a line which ascends through the vertebrate series up to man. It shows us in the faculty of understanding an appendage of the faculty of acting a more and more precise, more and more complex and supple adaptation of the consciousness of living beings to the conditions of existence that are made for them."

This complex series of unprovable statements is set down practically as embodying facts of science that may be assumed as certain, whereas scientists know that they are greatly contested speculations of a section of the scientific world. It ought surely to have been made plain at the outset that science, as we know it, deals not only with incontestable facts, but also with dogmatic principles which go far beyond what we can verify A philosophy such as Bergson's, which is built partly upon facts and partly upon scientific theories, cannot claim the same consideration as one which starts with facts alone.

But even when Bergson starts with facts, his inferences require to be received with due caution. Mr. A. J. Balfour points out very justly that

"Little importance can be attributed to the unverified visions attributed to the Hymenoptera"

It would be a little difficult to prove that the Hymenoptera suffer from any such philosophic weakness as visions. But this isolated instance of poetical rather than philosophical flight would not matter, if it were not accompanied by a habit of self-destructive inference from the facts of the present. Having postulated Creative Evolution as the one true cause of all that is, he proceeds to read the history of the present in the activity of this common source of organic life.

"Whether diverging lines of development show unlooked-for similarities or puzzling discords is all one to him. Either event finds him ready; in the first case the phenomenon is simply accounted for by community of origin; in the second case it is accounted for less simply, by his doctrine that each particular evolutionary road is easily overcrowded, and that if creative will insist on using it, something must be dropped by the way." *

The latter hypothesis shows a far too intimate acquaintance with the inner habits of the unnamed force which directs the history of evolution, although Bergson confesses that "documents are lacking to reconstruct this history in detail." When we come to such speculations as these, which are not unfrequent in Bergson's works, the question that they suggest is this: Is there any poetic or merely fanciful view of the universe that could not be maintained as a philosophic system, if we were at liberty to deal with our facts in this intimate and dexterous way?

But perhaps the shortest way to get at the heart of Bergson's speculations is to consider his conception of Duration. He exhorts us to master this conception by promptly installing ourselves in it, a thing, he says, which the intellect generally refuses to do; since the intellect is always bent on some practical object which can only be secured by considering the end of a process, of becoming.

"He who installs himself in becoming sees in duration the very life of things the fundamental reality. The Forms which the mind isolates and stores up in concept, are then only snapshots of the changing reality. They are moments gathered along the course of time, and just because we have cut the thread that binds them to time, they no longer endure They tend to withdraw into their own definition, that is to say, into the artificial reconstruction and symbolical expression which is their intellectual equivelant. They enter into eternity, if you will, but that which is eternal in them is just what is unreal. On the contrary, if we treat becoming by the cinematographical method, the Forms are no longer snapshots taken of the change; they are its constitutive elements, they represent all that is positive in Becoming." †

This comes to mean that time, as we commonly conceive it, does not exist, *viz.*, that it is a mere self-destroying illusion, or a "bastard space." There is no time that can be divided into homogeneous moments. We are the victims of our imagina-

* Balfour : *Hibbert Journal*, October, 1911

† *Creative Evolution*, p. 335

tions, when we look at things in this way; things do not require time to go through their successive states, but we require this idea of time in order that our imaginations may conceive of them as passing through successive states.

Add to this a distinction of time that is fundamental in Bergson's speculation. There is a time that is a symbol of space, and there is a time that is true duration; the one makes no difference to reality, the other is the stuff of which reality is made; and this distinction gives us the difference between a material thing and a living thing. For time affects (gnaws into) the animate but not the inanimate. This point is so vital to Bergson's theories that I give his own exposition of it word for word:

"Real duration is that duration which gnaws on things, and the same concrete reality never recurs. Repetition is therefore only possible in the abstract: what is repeated is some aspect that our senses, and especially our intellect, have singled out from reality; first because our action, upon which all the effort of our intellect is directed, can move only among repetitions. Thus, concentrated on that which repeats, solely preoccupied in welding the same to the same, intellect turns away from the vision of time. It dislikes what is fluid and solidifies everything it touches. We do not think real time. But we *live* it, because life transcends intellect." *

But Bergson goes a step further, and gives time a position in the scheme of things, which is most striking. It is a force, inseparable from the creative consciousness, which causes the universe to unfold the successive stages of its evolution. If words have any meaning, we must regard it as an agent in that continuous process of free creation which is life itself.

If these flights of Mr. Bergson's speculative mind were ever to gain the assent of the general body of thinkers, our view of the universe would indeed be revolutionised. But restricting our thoughts to the above data with regard to time and duration we may safely say that there are many difficulties to be smoothed away before Bergson's theories become general.

The exhortation with which Bergson opens this inquiry into the nature of duration is characteristic of his whole method: we are to take our stand in the very centre of the process of becoming, by an effort of sympathy which will enable us to feel all the palpitating riches of the process. Unfortunately, he omits to tell us how his instructions can be carried out, and when we see how he has carried out his own exhortation we are bewildered. He has been so overcome by the thought of being able to enter into the intimate reasons of becoming, and of measuring the process in living things (which he calls real duration), that he has carried away the superexalted notion that what he seems to have observed is the whole of reality, the very life of things. In his new-found fervour he sweeps away as useless in philosophy all the notions of common sense by classing them as the mere sedimentary deposits of intuition, which is to be the choice instrument of philosophic knowledge.

* *Creative Evolution*, p. 48.

Let us see where this intuition has led him. Here is its first voyage of discovery: time is the fundamental reality by means of which the Forms which the intellect isolates and stores up in concepts come to have positive constituents in being. You can never reconstitute movement, he says, with these Forms. But the very cinematographical nature of our intellectual mechanism, which he proclaims, goes to show the very opposite. You cannot create movement in the world outside the intellect by means of these Forms, but surely you can obtain a perfectly true idea of what this movement is, if you use the mechanism properly. In speculations on movement and becoming our object is not to reproduce these things, but to gain true conceptions of what they are.

Bergson places the emphasis on the wrong word of the above formula, when he tells us that time is the very life of things. For these Forms can be said indeed to represent much that is positive and fixed in the things themselves. But time does not constitute the reality of the things that are snapshotted. It is merely the *condito sine qua non* of their existence and movement within our experience.

You might as truly call light the whole fundamental reality of seeing as say that time is the fundamental reality of becoming. If there were nothing real corresponding to our mental forms which could be constituted in time, then time would be a living reality which would be full of emptiness. Hence the objects which the intellect snapshots, and which take the form of mental pictures in the mind, are more deserving of the name of fundamental reality than any duration which may accompany them either in *rerum natura* or in the mind. These objects are ever the foundation of such reality as time may be said to possess. and so they can be said to constitute the fundamental reality of time, not *vice versa*.

It would seem that Bergson's next conclusion, *viz.,* that time, as a succession of homogeneous moments, is a mere delusion of the imagination, has been derived rather from Berkeley and Hume than through the new philosophical instrument of intuition. It is not the average observer, but the new philosopher, whose imagination is at fault in considering the succession of time. For Bergson imagines a process of evolution in which the past, present, and future are so interpermeated that a future state may influence the present as a cause. He conceives, after the fashion of the Neo-Hegelians, a real mental life in an eternal present (which intuition can be trained to discern), where past, present and future meet in an ever-present now. That this may be possible somewhere and somehow we are not prepared to deny. But we can safely deny that our present experience gives us any knowledge of it in the world that science can examine. If, therefore, the new philosophy gets rid of time in the common-sense meaning, it is postulating as facts of experience two things of which we have no experience: (1) An effect before the cause; (2) a past and future simultaneous with the present.

But "time is nothing but the ghost of space haunting the reflective consciousness," says Bergson. Using the same poetic licence, may we not rather say that it is the solid shadow of a space that is real, projected on the receptive consciousness of man?

It may be called the measure of the duration of a movement which takes place in space. There will be a harmony, a proportion, some dependence between time and space; but they must not be confused; for there are changes which can only take place when there is sufficient time in which to perform them, and no amount of space can be a sufficient substitute for the required time. Take the case brought forward as an example by Bergson, that of the sugar melting in a glass of water. Provide the most ample glass, make it a reservoir if you like, but you will not then escape the necessity of waiting until the customary time has passed, moment by moment. There are changes which take place in periods of time which are so steadfast that the moment can be predicted when the movement of change will end. Sometimes different movements as measured by time will take place within the same space. The fact that we can predict them successfully shows clearly that time is something more than a bastard space.

True, time is as a rule conveniently represented by symbols of space; but this only means that space is a condition of all that can be known through the senses. But if you wish to see how fatal any confusion of the two ideas becomes, consider Zeno's problem of Achilles and the tortoise. Treat time and space in exactly the same way and you will come to the conclusion that Achilles can never overtake the tortoise. As a matter of fact he will overtake the tortoise in a very short time. You may divide up the space between the runner and the tortoise an infinite number of times, if you will. But whilst you are using the knife on space, Achilles is moving on in time to overtake both the knife and the tortoise, which would seem to prove that time has a way of its own, whatever the operations you may choose to perform on space.

But what of the difference from the point of view of time, that Bergson endeavours to establish between the living and the non-living? In so far as the living organism has its extension in space, it seems to be in exactly the same position with regard to time, as the inorganic. Both are "gnawed into" by the tooth of time: the solid block of granite and the delicate tones of the prima-donna. Inanimate things are, if anything, at a disadvantage, since they have no defence against the ravages of time, though on the other hand they change more slowly, and they usually have a longer duration. The same duration of time in the concrete may be the measure of a thousand movements differing in kind, movements of things animate and inanimate.

Rather than say with Bergson that intellect turns away from the vision of time, we prefer to hold that time eludes the grasp of intellect, not because time is unreal, but because it is one of those ultimate conceptions, which are seen even when our vision is difficult to put into precise words. It would be absurd to deny the fundamental reality of time either because we cannot define it fully ourselves or because we hold that inanimate things are not conscious of time. But whilst refusing to grant any reality to time as usually conceived, Bergson has imagined a gradually evolving duration which is the cause of all that becomes. This *Chronos* of his, will seem no more capable of being a subject of intuition to many than his mythological counterpart. But to enter that part of the theory of *Creative* Evolution would lead us far beyond my proposed discussion of time and duration.

It is especially in regard to this new conception of Bergson's that we must quote the words of a follower and admirer; though in a sense opposite to that in which the words were originally used :

"Bergson claims of us first of all a certain inner catastrophe, and not every one is capable of such a logical revolution." *

To substitute intuition for argument in matters that are either scientific or philosophical is without doubt a considerable revolution in logic. We can quite believe that anyone who has once made the somersault will find it difficult to revert to a normal position.

TRANSACTIONS OF SOCIETIES.

Geological Society of South Africa.—Monday, September 30th: Mr. H. S. Harger, President, in the chair.—"The occurrence of Sideroplesite and Ankerite in the Cassiterite lodes at Rooiberg": D. P. **MoDcnald.** The lode matter in connection with the tin deposits at Rooiberg consists commonly of sericite, tourmaline and cassiterite. The sericite may be replaced by quartz or by sideroplesite, the introduction of carbonates being later than the deposition of the cassiterite.—"Note on the origin of the iridosmine in the Banket": Dr. R. B. **Young.** The author believes the iridosmine to be an original constituent of the banket, and bases his opinion that it is of detrital origin, *inter alia*, on the rounded form of the mineral grains and their association with detrital chromite, both being probably derived from ultra basic rocks in the Swaziland system.

South African Society of Civil Engineers.—Wednesday, October 9th: Mr. R. W. Menmuir, A.M.I.C.E., in the chair.—"Renewals of bridges; Eastern line, Transvaal": A. **Reynolds.** The section of railway line between Witbank and Resano Garcia on the Portuguese border was dealt with, the majority of the bridges being situated in the low veld.

Royal Society of South Africa.—Wednesday, August 21st: Dr. J. K. E. Halm, Vice-President, in the chair.—"The blizzard of June 9-12, 1902": A. G. **Howard.** In continuation of a previous paper by Mr.

* Gaston Rogeot quoted by W. James in *A Pluralistic Universe*, p. 266.

C. M. Stewart (see 1904 Report of S.A. Association for Advancement of Science, page 118) the author brought to notice a series of synoptic charts of the weather conditions from June 8th to 13th, 1902. It was concluded that the condition shown was the only one that could bring a blizzard over the East.—"A list of South African lacertilia, ophidia, and batrachia in the McGregor Museum, Kimberley, with field notes on various species": J. **Hewitt.** and J. H. **Power.** The present-day fauna of the Kimberley district is shown to be composite, a new element having been introduced along with timber from Bechuanaland.—"On the salivary and mouth glands of the nudibranchiata": Dr. T. F. **Dreyer.**—"The leaf-spots of *Richardia albo-maculata* Hook": W. T. **Saxton.** The structure and development of the white streaks in the leaves of two species of *Richardia* were described, and their origin discussed. These spots are conspicuous in the mature leaf, but absent from very young leaves. They differ from the white regions of the ordinary type of variegated leaf in the fact that the palisade parenchyma is quite absent. Plastids are very scarce within the area of the leaf spots.—"Some new or little-known South African succulents": Prof. R. **Marloth.** The plants specially dealt with comprised *Crassula teres,* which belongs to the small subgenus Pyramidella; *Euphorbia ferox*, which forms lumps about a foot in diameter, coloured brown like the soil, and provided with a formidable armament of stout spines; *Aloe purpurascens,* hitherto known only from cultivated specimens, but recently procured by the author from the mouth of the Klein River.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, September 21st: W. R. Dowling, M.I.M.M., President, in the chair.—"A Research upon a refractory Gold ore": M. **Green.** A typically refractory ore from the Mount Morgan mine in the Barberton District, which had long withstood all attempts to treat it successfully, had been thoroughly investigated. The results of the investigation were detailed and a scheme for complete treatment of the ore was outlined.

South African Institution of Engineers.—Saturday, October 12th: Mr. J. A. Yule, President, in the chair.—"The braking of high-speed winding engines": G. K. **Chambers.** The author referred to the difficulties encountered in the braking of high-speed hoists. If the maximum duty is to be obtained from a high-speed hoist under all conditions, power braking must be resorted to in order to bring the speed within the safe limits of mechanical braking. The various systems of power braking were then discussed under the heads of (1) non-generative or power-consuming systems, (2) regenerative systems, and (3) self-generative systems.

NEW BOOKS.

Marshall, H. E.—*South Africa's Story.* 8vo., pp. 99. London and Edinburgh: T. C. & E. C. Jack. 11 oz., 1s. 6d.

Browne, Col. G. H.—*A Lost Legionary in South Africa.* 8vo., pp. 308. Illus. London: T. Werner Laurie. 1912. 26 oz., 12s. 6d.

Melland, F. H. and E. H. Cholmeley.—*Through the heart of Africa.* 8vo., pp. xvii, 305. Maps and Illus. London: Constable & Co. 1912. 32 oz., 12s. 6d.

Junod, H. A.—*The life of a South African tribe: I. The Social life.* 9 in. × 6 in., pp. 500. Map and illus. London: D. Nutt. 1912. 8s. 6d.

Schwarz, E. H. L.—*South African Geology.* 12 mo., pp. vi, 200. London: Blackie & Son. 1912. 12 oz., 3s. 6d.

Scully, W. C.—*The Ridge of the White Waters: or, Impressions of a visit to Johannesburg; with some notes of Durban, Delagoa Bay and the Low Country.* Post 8vo., pp. 268. Illus. London: Stanley, Paul & Co. 1912. 18 oz., 6s.

SOME NOTES CONCERNING A DEEP BORE AT ZWARTKOPS, NEAR PORT ELIZABETH, AND THE RESULTING THERMAL CHALYBEATE SPRING.

Plate 3.

By George William Smith, A.M.I.C.E.

The following article lays no claim to be in any way of a scientific nature—it is simply a brief account of the reasons why this bore came to be drilled, with some remarks on the work of drilling it—what the resulting spring has done hitherto, and what it is capable of doing with further development.

In the Report of the South African Association for the Advancement of Science for 1910 (pp. 202 and 203) will be found an interesting paper on "A new Cape Thermal Chalybeate Spring," by Mr. J. G. Rose, F.C.S., treated from a chemical point of view. Mr. Rose was the first to detect that the water possessed any special value, the "find" being, up to that time, looked upon as rather an unwelcome discovery, owing to the volume of water, with its great heat and pressure, putting a stop to the drilling operations at about 400 feet short of what was originally intended.

The idea of putting down a deep bore to prove what lay under the surface, was largely undertaken from a spirit of adventure, partly assisted by various vague rumours of traces of oil having been found at places in the Zwartkops River Valley and also on the margin of the Groot Pan in the Zwartkops Heights, and as all these localities were in the regions of the salt-pans some colour was given to the reports, as salt is a well-known accompaniment of petroleum.

Nearly all the early discoveries of petroleum in America were made in connection with the deepening of brine wells in the salt districts, and its appearance was at first looked upon as a calamity. In the rich oil fields of Galicia, which is a salt-producing country, salt is found on the surface, and it is brought up from a depth of 4,000 feet on the drilling tools. Sir Boverton Redwood, in his standard work on "Petroleum," mentions that "Throughout the globe the association of gas and petroleum with salt is universal," and another equally reliable authority says: "Although salt is found without petroleum, petroleum is seldom found without salt."

A chain of salt-pans it may be known, extends from the North End of Port Elizabeth for about 12 miles in a north-western direction; some are filled up with sand, one is used as a boating lake, and two are worked for salt. The most northern one, called the "Groot Pan," is stated to produce as much as 300 tons of salt per day during the season, and this has been going on for many years without any signs of diminution.

It is not intended here to discuss the various theories that have been submitted to account for the presence of these salt-pans—this has all been very ably set forth in the reports of the

Cape Government Geologists, but, as far as can be gathered, there is still a good deal to be learnt about this subject.

With the exception of a salt-pan near Pretoria, there is no record of these salt-pans having been tested at depth—at this pan, however, a bore appears to have been put down to a depth of 188 feet, and it is on record that

"It proved the existence of a considerable body of 'natron,' together with a 2-feet thick layer of pure carbonate of soda at about 14 feet from the surface, and the existence of the pan was attributed to volcanic action."

Petroleum authorities state that oil is not confined to any special series of rocks; it is found in the formations of all ages; some understand it to be a production from vegetable matter, and others that it is derived from the sea weeds and molluscs of the ocean of past ages. It is found at various altitudes, and in California it is pumped from below the sea, and some authorities maintain that the chief of the world's supply of petroleum lies below the ocean bed; indeed there seems to be comparatively few conditions under which it is impossible to find this oil.

And so this small Company proposed to make an attempt to prove what was below the surface in the vicinity of Port Elizabeth. Some difficulty was experienced in obtaining a salt-pan in the district, as these were already held by companies or corporations. Eventually, however, a small pan was leased from Government, but it was found to be rather out of the way and difficult for the conveyance of fuel and water. It was therefore abandoned in favour of a more suitable site for railway and water facilities, while it was not far removed from the salt-pan that was proposed to be tested.

The capital of the Company, which was £13,000, was all subscribed locally, and the whole of this sum was expended in actual works. Before any active operations were begun the best information was obtained as to the proper class of tools to employ by a personal inspection of the methods practised in the great oilfields of Galicia, where the wells are from 2,500 to 4,000 feet deep, and even deeper, with the result that from this district a complete drilling plant of the most modern pattern was purchased, competent drillers employed, and the tools and men despatched to Port Elizabeth, where they arrived in the early part of February, 1908.

The first month or six weeks after arrival was chiefly employed in the erection of houses, fencing ground and the erection of the engine, derrick and drilling plant. An electric light installation, forming part of the plant, was also erected, so that the work of drilling was kept going night and day. An endeavour was made to start work by inserting a wooden crib. three feet in diameter, in two lengths of 12 feet each, but immediately below the surface large boulders, water and running sand were met with, and little progress was made until the engine was at work and some special 18-inch iron steel tubing procured, but eventually, after passing through 82 feet of sand, boulders, etc., the steel casing was bottomed in hard blue clay, after which the work proceeded more satisfactorily.

It may be briefly explained here that oil wells are as a rule drilled with the "jumper" variety of tools as distinguished from the "diamond" drill, which is used in proving mineral fields where the strata are hard, the resulting "core" being brought up solid, as the drill cuts it out of the rock by means of a "crown of rough diamonds" but should this diamond drill come across any soft strata or clay the probability is that the tools will get clogged, and result in the loss of the tools and also the hole.

The "jumper" drill, on the other hand, is effective in either hard or soft strata. Instead of beginning the hole 3 or 4 inches diameter, as with the diamond drill, it is begun at, say, 18 inches diameter, and in this case is wide enough to allow the steel casing to go down as soon after the drill as possible. The material, instead of coming out as a solid core, is pulverised by the steel bits secured to the end of the drilling rods, water is added to the stuff so pounded and the resulting sludge is brought to the surface by a species of pump let down the hole by a wire rope. Each bit is about 6 feet long and in breadth from 14 inches to 5 inches, and is used according to the size of the hole to be drilled. They are changed as soon as the cutting edge becomes blunted, and this again depends on the hardness of the rock. Usually the bit will last for two hours, but in some parts of this bore a quarter of an hour was enough. The bit is secured to the bottom of the rod by a screw; there are many technical and clever devices in connection with this description of plant that cannot be referred to here. The work of drilling seems very simple, but it requires the utmost care and experience in handling the tools, as the weight runs into several tons, and a small slip or carelessness may result in a bad accident, if not in wrecking the hole. With the exception of a 4-foot crowbar and several similar articles falling down the hole to a depth of from 2,000 to 3,000 feet, there were no mishaps. These articles were all recovered by improvised tools and in a short time. Special fishing tools were sent out with the plant for recovering heavy articles or damaged casing, but no necessity arose for using them.

The engine sent with the plant was of 35 nominal horse-power, which worked an oak walking beam of great strength. The outer end of this walking beam carried the string of iron rods on which the bit was screwed as already described. A wire rope is sometimes used for drilling in America and elsewhere where the bore is shallow, but for deep bores, where great accuracy is required, the iron rods are best. The time occupied in screwing and unscrewing 3,000 feet of rods 30 feet long may be considerable, but it well repays the extra trouble.

As soon as a sufficient length of hole is drilled steel casing or lining is introduced to prevent the sides collapsing. The whole of this well is cased from top to bottom; first there is about 80 feet of 18-inch casing, inside that 960 feet of 10-inch casing, inside that 1,330 feet of 9-inch casing, and so on with 8-inch, 6-inch and 5-inch, which is the innermost size, and was designed to be carried down to 4,000 feet. The total length of casing in this bore is a little over two miles, and represents a money value of about £1,400. If the bore had to be abandoned the greater part of the casing could be recovered, but in this case it has to be left in to preserve the bore from closing.

The derrick, together with the engine and gearing, had to be covered in as a protection against the weather and for night work. The boiler is placed at a regulation distance from the bore in case of an outburst of gas, which usually accompanies oil.

The serious work of drilling began after passing through the layer of boulders and running sand in April, 1908, and drilling was stopped on the last day of October, 1909, at a depth of 3,620 feet. After entering the bed of blue clay at 80 feet, bands of marl, sandstones, etc., were passed through down to 917 feet, where a bed of sandstone 70 feet thick was met with; then more clays, shales, and sandstones in bands to 1,570 feet, where a second bed of sandstone was met with 110 feet thick, and again more marl and shales, with bands of sandstone to 3,234 feet, where the beginning of the sandstone was reached that at 3,404 feet yielded the first of the hot spring; this sandstone remained till the bottom of the bore at 3,620 feet.

The rate of progress at first averaged about 14 feet per day, but for the latter half down to 3,200 feet only 8 feet; this included time occupied in changing bits and putting in casing. From 3,200 feet to 3,400 the progress was even slower owing to the increased depth, but after the spring was struck at 3,400 feet the upward pressure of the water was so great that the tools, although weighing about seven tons, could make very little progress, a full blow could not be struck, the drill seemed to rebound as from a cushion, and about 1½ feet per day was the whole progress, and the result was a little coarse, gritty sand, much stained with iron, which was shot up by the water. The pressure gauge placed on the pipes after the bore was capped registered upwards of 100 lbs. to the square inch.

Three springs of fresh water were passed through at 960, 1,250 and 1,530 feet respectively, also a salt brine spring at 2,480 feet. All of these rose to the surface, but were shut off by the casing in turn as the various lengths were put down. All these springs were cold and gave no indication of the hot spring met with 900 feet below.

From 1,430 feet to 2,670 feet a variety of small shells was found embedded in the clays and in a fairly good state of preservation, although the tools destroyed a large number. Through the good offices of Dr. A. W. Rogers, of the Government Geological Department, these were sent to Dr. Kitchen, of the Geological Survey of Great Britain, who reported and classified them, assigning to each of the eight samples sent the probable geological position they occupied. A copy of this report will be found in Appendix "A."

At the depth of 3,400 feet the boring bit struck the first of the hot spring, the volume being about 3,500 gallons per day and the temperature 105°. As the bore went deeper the volume gradually increased, till 3,560 feet was reached, when the volume increased to 250,000 gallons per day and the temperature to 130°. A further depth of 60 feet was drilled, but there was no increase of water or heat, and as the water pressure had become a real difficulty and little progress was being made, it was decided to stop work—particularly as the water was found to possess some value, and as it was possible a deeper cold spring might be struck that would destroy its properties, and thus the work of drilling had most reluctantly to be brought to an end at 400 feet short of the distance intended.

An attempt was made to ascertain the temperature of the water at the bottom of the bore, but with such appliances as were at hand no perceptible increase could be found on the self-registering thermometer sent down after the surrounding strata were thoroughly warmed up.

The drilling plant, with the engine and boiler and electric installation, cost £3,400, and the casing about £1,400 more. The working cost of drilling averaged about 20s. per foot down to about 3,400 . When the spring was struck, the cost mounted up considerably, and when the work was stopped it had reached about £8 per foot, as the tools had seemingly lost their power of drilling and only scraped the bottom. The resulting coarse, gritty sand, as already stated, was much stained by iron.

As soon as it was decided to stop work, the depth of the bore was carefully measured, the tools collected, cleaned, oiled and packed away carefully under cover for future use when required, and the men sent back to their homes in Galicia.

There were, fortunately, no accidents of any sort and the men were thoroughly competent and resourceful.

Although there were no absolute evidences of oil found in the bore, a little gas was given off at about 2,800 feet and some rings of natural wax came up in the water about the same time. The brine spring was considered a good sign by the drillers, who entertained the hope that the hard rock on which the bore was stopped might be the "cap" frequently found over oil strata. The chief driller encountered a similar hot spring in drilling in Persia, which yielded a flowing oil well 200 feet further down, and recently a newspaper notice mentioned a similar case in drilling in the Argentine Republic, so that it was a matter of regret that the rest of the distance could not be accomplished.

The Thermal Chalybeate Spring.

The disappointment occasioned by the stoppage of the drilling before completing the work that the company had set out to do was somewhat modified by the discovery that the spring possessed the valuable qualities attributed to it, and by way of experiment, and on the suggestion of the medical profession, four baths were erected near the spring, which had the effect of tempting one or two rheumatic subjects from Port Elizabeth. Their report of the visit was so satisfactory that the visitors increased rapidly, until last year the number of baths taken was 7,000 and the visitors about 3,000, patients coming from all parts of the Cape Province as well as from the Free State, Transvaal and Rhodesia.

A few more bath rooms were added, but the accommodation is at times far short of requirements. The site of the bore is, unfortunately, only a few feet above high water mark, so that it is not advisable to erect any permanent structure there. A new site on an adjacent rising ground is being negotiated for, where it is contemplated building a properly-equipped sanatorium on modern lines, to which the water will be carried in properly insulated pipes on an approved system, which will permit the water and gases to be delivered into the baths as at present, without any contact with the atmosphere and with very small loss of temperature.

Meanwhile the lessee of the baths receives into his house, which is close to the bore, a few boarders, and so also does the Zwartkops Hotel, but the accommodation is very limited, and the applications are far in excess of what can be provided for. It is hoped that about 40 bedrooms will be included in the new scheme and 16 bath rooms under the same roof, which will be increased as requirements demand.

The subject of the curative properties of this water does not fall within the scope of this article. Patients suffering from serious complaints other than rheumatism and kindred ailments have been wonderfully benefited and have gone home apparently cured.

Several analyses of the water have been made, but only after it had been conveyed a considerable distance. No tests have as yet been made at the bore itself, where the best results are likely to be had; so that there is still something to be learned about this spring and its attendant gases.

The following, however, may be given as to the properties of the water as compared with the well-known waters of Caledon:—

Zwartkops.	Grains per Gallon.	Caledon.	Grains per Gallon.
Sodium Chloride	25.57	Potassium Chloride ..	2.81
Sodium Sulphate	.61	Sodium Chloride	1.74
Calcium Carbonate ..	1.57	Calcium Chloride	1.31
Magnesium Sulphate ..	2.12	Calcium Carbonate.. ..	.21
Magnesium Carbonate	2.21	Magnesium Carbonate	.58
Ferrous Carbonate.. ..	1.86	Magnesium Chloride ..	.27
		Ferrous Carbonate.. ..	1.93
Temperature 130° F.		Temperature 120° F.	

G. W. SMITH. A deep bore at Zwartkops.

The Government Analyst adds in his report that until the discovery of this spring, that of Caledon was said to be the only high temperature Chalybeate spring in the world, but this spring being 10° F. higher, the former has now lost that distinction.

In order to test the effect of the water on various metals, samples of copper, brass, galvanised iron, zinc, lead, aluminium, etc., were put in the running stream for six months, carefully weighed before and after immersion, and the result is given in Appendix "B."

It might be interesting to note that Sir Wm. Ramsay, in addressing a meeting recently at Bath, where he had been conducting a series of scientific investigations in connection with the waters and gases from King's Wells there, said that in 10,000 volumes of the gases from King's Well there were 12 volumes of Helium. It was not evident how the presence of Helium could be credited with such beneficial results as were produced by "taking the waters," but in 1903 the riddle was solved by the discovery that Helium was one of the products of change of Radium; and he also stated that the yellow discolouration of the glasses used for drinking the water was not due to iron as hitherto supposed, but to Radium.

As the discolouration of the glasses at Zwartkops spring is very pronounced, a field of research is opened up to find how far this is due to the presence of Radium and in what degree, and this can only be done at the bore itself.

Bottling the Water.

Experiments have been made in bottling this water for the market. It is brought into town in jars and aerated in the usual way, and, so far, is much appreciated, having gained three first prizes in open competition; but what is aimed at is to bottle the water with its gases and without its having any contact with the atmosphere. This we are assured can be done by means of special appliances, but this section must stand over till the more pressing needs of a sanatorium can be attended to.

The foregoing is a brief outline of the history of this work, which was originally undertaken in the hope of finding some definite evidences of the existence of petroleum, but which has resulted in the discovery of a thermal spring unique in its way, as its waters are encased in steel pipes from its source of origin 3,600 feet below the surface all the way to the baths without its coming in contact with the atmosphere. So that whatever the properties may be that the water or the accompanying gases possess at that depth, the same virtues are delivered without loss into the baths, and, as far as is known, there is no other spring in the world that has this peculiar advantage.

The proposed site for the sanatorium is on rising ground close to the sea, and also to the excellent fishing and boating facilities in the Zwartkops River. It is situated at the junction of the two main lines of railways reaching into the interior, and it is convenient also to Port Elizabeth. So that if the prospects of immediate benefit have been clouded by the failure in finding petroleum in the bore, it is just within the bounds of possibility that a more permanent advantage has been gained, that may develop into far-reaching results.

APPENDIX "A."

Extract of a Report by Dr. Kitchen to Dr. Rogers regarding fossils obtained from the Zwartkops Borehole.

1,430 ft. *Modiola* species (Ornate; probably new species).
2,100 ft. *Cyrena*? and Cyprids.
2,190 ft. Gasteropod, indeterminate (with high body-whorl and elevated spire; possibly *Limnæa* or allied form).
2,335 ft. Crushed lamellibranchs; perhaps *Cyrena*; also *Viviparus* (*Paludina*).
2,500 ft. Laminated clay crowded with Cyprids; probably *Cypris* or *Cypridia*.
2,600 ft. *Modiola* species (unornamented); *Melania* species.
2,670 ft. Fragments of *Modiola* and other shells *Bythinia*, or perhaps *Viviparus*, with detached spire.

I take all these clays to be from an estuarine and fresh-water series of Wealden facies; and although there is no decisive palæontological evidence for a Wealden age, I should think that they may well be in part contemporaneous with the marine fauna of the Uitenhage series, and perhaps in part of the earlier Neocomian age. Accurate correlation with the marine facies, on palæontological grounds, is of course excluded.

Many of the crushed lamellibranchs are probably referable to *Cyrena*, but the correctness of this reference could only be proved by ascertaining the nature of the hinge, and, unfortunately, no hinges can be seen in the specimens sent; but the shape, so far as this can be made out, and the concentric linear markings of the external surface, are compatible with this determination.

The character of this bluish-green clay and the mode of preservation of the fossils are strongly reminiscent of some of the Wealden clays of England.

(Sgd.) F. L. Kitchen.

APPENDIX "B."

Seven samples of the following metals were placed in the running stream of the water for six months. These were wholly submerged and without contact the one with the other.

The samples were carefully weighed before putting in, and were dried and cleaned with a brush before reweighing.

The aluminium samples were, unfortunately, lost before the six months expired, and a new sample was weighed and taken out after five months' treatment in the running water.

The following is the result:—

Metal.	Before.	After.
Copper.	504 grains	571 grains.
Copper, tinned on sides . .	511 grains	516 grains.
Brass	312 grains	304 grains.
Galv. Iron . .	466 grains	420 grains.
Zinc	220 grains	185 grains.
Lead	2.172 grains	2.096 grains.
Aluminium . .	160 grains	205 grains.

Some larger samples of iron piping were put in the water at the same time and are still there. The galvanised iron tubing seems to have suffered less deterioration than the others, but none of the larger samples were weighed.

Modern Tendency of Physical Science.—On the 17th October last Sir Oliver Lodge delivered, before the Chemical Society, the Becquerel Memorial Lecture, in which he summarised the influences on the course of physical science of the epoch-marking discovery made by Henri Becquerel, in 1896, that uranium compounds possess the power of emitting rays analogous to those associated with the name of Röntgen. Some of the lecturer's remarks are extracted below:—

"The atmosphere of physical science at the present time is rather a strange one. . . . There was a time, within easy memory, when the progress of discovery was placid and peaceful. It seemed to proceed along well-worn channels, and to be based upon the most thoroughly substantial knowledge of the past. . . . . Philosophers and biologists attended to their own fields of work, and so, for the most part, did mathematicians and chemists; each group proceeding on its own lines, without much regard for the others. Now all is changed:—

"Chemistry has borrowed the idea of evolution from biology, and is trying to extend it from the origin of species to the origin of atoms; though some chemists reject all this as baseless speculation, and pour modulated scorn upon the few recent discoveries which physicists are willing to accept.

"Biologists have been ultra-speculative in their quest for the origin of life, and are turning their attention to metaphysics and philosophy, some of them in an energetic and pugnacious manner.

"Mathematicians disport themselves destructively among what have seemed the realities, the very data, of physics; distributing an atmosphere of doubt and hesitation almost equally over space, time, matter, and motion, and treating the ether with a veiled contempt.

"Philosophers question the correctness of our most fundamental laws—doubting, for instance, even the conservation of energy, and readily assimilating the sceptical utterances of those whom I have for the nonce described as mathematicians, though it is but an active group or school of mathematicians who take this line.

"And Physicists, or some of them, are seeking to dispense with Newton's laws of motion, to supersede that dynamical basis on which they have built for so long, to regard all laws as merely conveniences of expression, and are trying if they can manage to sustain their science on a basis of action at a distance, fluid electricity, corpuscular light, and caloric heat.

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"Discoveries are of two chief kinds—the discovery of law and the discovery of fact. The two tend to become inextricably interwoven: the discovery of law often leads to the discovery of new facts, and the discovery of new facts to either the formulation of new laws or new modes of statement, or to the resuscitation of discarded ones.

"As examples of the discovery of *law*, I instance Newton's gravitational theory of astronomy, and Maxwell's electromagnetic theory of light. Discoveries of this kind take their place among the most prodigious efforts of the human intellect.

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"Of all the facts discovered during the last half-century, I suppose that Röntgen's *X*-rays excited the most popular astonishment; and certainly they were sufficiently new. Nevertheless, existing theory had a place for them. . . . . If called upon to compare the discovery of Röntgen with the discovery of Becquerel, I should give the palm of novelty to the latter; for the spontaneous splitting up of atoms, and the consequent expulsion of constituent fragments, was not provided for on any theory. It was a revolutionary new fact.

. . . . . .

"It is needless to emphasise the extraordinary suggestiveness which the instability and intense energy of atomic structure, thus demonstrated, confers upon our ideas of material atoms in general, since it is surely probable that the stability of the atom of the better-known elements, especially of the heavy ones like lead, mercury, and gold, is, after all, only a question of degree. Some substances last a few minutes, others a few weeks or years, some centuries, and others millions of æons—these last being naturally more plentiful, like a population with a low death-rate—yet it must surely be considered unlikely that any such atomic groupings are so devoid of internal energy as to be endowed with an absolutely permanent structure incapable of further subdivision.

. . . . . .

"So far, it has all seemed plain sailing; but now has come the era of scepticism, and an attempt to limit science to purely material entities and to reduce Physics to a sort of glorified Chemistry, to return, in fact, to the kind of ideas which prevailed in the golden age of Chemistry, near the early part of last century, and to discard everything relating to an ether of space.

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"The ionisation doctrine and its many developments may be regarded as an encroachment of physics on the preserves of chemistry, since it has certainly modified ideas about the nature of solution; but there is a converse process now going on, and in the course of a sort of triumphant materialisation of obscure entities, achieved at any rate hypothetically and speculatively, if not yet in any substantial manner, Chemistry seems to be dominating emancipated parts of Physics.

"The latest and most astonishing attempt towards the reconversion of Physics into Chemistry appears in a brilliantly clever and apparently serious address to Section A by Professor Callendar, this year, on the resuscitation of caloric or the material theory of heat—a theory which carries with it the ancient view that physical changes of state, such as vaporisation and liquefaction, are really the solution of matter in the substance of that apparently imponderable material caloric, and *vice versa*.

"After this it is barely surprising to hear the biologists call upon the chemists to explain the phenomenon of life, and to produce in their glass vessels—if only they can stumble on the right environment, and on a judiciously combined assortment of material—some low form of living matter.

"In view of the remarkable experiments recently made on the influence of various strengths of mere salt solutions in fertilisation and cross-breeding, it is not surprising that an anticipation of the kind should be promulgated. At present it is no more than a speculation, but if followed up, although it may not lead to the result anticipated, it may lead to others of perhaps equal interest.

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"All this tendency to return to discarded hypotheses and revivify old beliefs—for spontaneous generation is, I suppose, a very old belief or superstition—is a matter of great interest; and it is astonishing to find how much can still be said for ancient views. Forty years ago the Caloric theory of heat seemed dead beyond redemption, and I do not say it yet lives, but the ingenuity of Professor Callendar finds a great deal to say for it, some of it of a cogent kind; it appears to be quite a possible mode of expressing facts, and one that is perhaps convenient for several non-elementary purposes.

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"Then, again, in early days it was customary to jeer at the prevalent popular habit of speaking of electricity as a fluid, and until we knew more about it the practice was certainly to be deprecated; but now, in the light of further knowledge, something very like an improved and more definite fluid theory seems likely to hold the field.

"Hitherto Röntgen radiation has seemed to belong almost wholly to Physics, whilst Becquerel radiation belonged largely also to Chemistry, to which science our friend the late Dr. Russell's radiation or emanation has always belonged wholly; but now judgment as to the nature of Röntgen rays may have to be regarded as open to revision.

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"Amid this sea of conflicting hypotheses and guesses, what should be our attitude? And how far should we condemn those philosophers who, in their anxiety to stem the tide of materialistic philosophy (in which enterprise I for one am a sympathiser), have tried to throw doubt upon certain well-established and fundamental laws of physics—an enterprise wherein, as in duty bound, I part company with them?

"I urge that our attitude should be this:—

"Let us admit that any law applicable to concrete objects (not merely to abstractions), and established by induction on a basis of experience, must necessarily be of the nature of a postulate; but let us hold some of the postulates as so well established and secure that any argument that would necessitate their overhauling is *ipso facto* to that extent discredited, and not to be countenanced unless supported by new and revolutionary facts; and even these new facts we must try to explain in harmony with all well-established laws, rather than as disturbing or negativing them.

"In other words, let us seek to reconcile all new facts with the fundamental laws of physics, applied in a proper manner, until compelled to cast about for some higher generalisation. For in all probability that higher generalisation, when it comes, will be supplementary rather than superseding; and the conditions which necessitate its admission will be specifiable and definite when the subject is properly understood.

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"Some mathematicians, among them the late Professor Poincaré, are willing to give away their kindred subject of Physics by admitting or maintaining that our laws are not important statements of fact, but are only conveniences of expression. And many philosophers seem eager to accept this vicarious generosity at their hands.

"But such repudiation of our claims and reduction of our life work to insignificance, I altogether deprecate. If we are not seeking real truth, if we are only seeking convenience of expression, the science of physics is not the noble structure which I, for one, think it.

"To take the simplest and most rudimentary example:—

"Are we to suppose that it is only a matter of convenience whether we say that the earth turns on its axis, or that the host of heaven revolves round it once a day? I hold that the one is a genuine and absolute truth, whilst the other is a genuine and absolute falsehood; and that convenience of expression has nothing whatever to do with the matter, except that the truth must always be ultimately more convenient than error; just as I say that it is true that a train is travelling over the surface of the country, and not true that the ploughed fields and hedgerows are contorting themselves in the eyes of stationary travellers. The relativity of motion, thus pressed, and taking matter alone into account, is really absurd. Yet those who discard the ether are constrained to assert that there is no pragmatic difference between the two forms of statement, and no mode of ascertaining which is true: no meaning, in fact, in absolute motion at all.

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"The great thing to avoid in science is negations. Let us make and substantiate positive assertions. But negative assertions—statements as to what does not happen, or what is not possible—although occasionally necessary, are always dangerous, and should be kept in rigorous check.

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"Those who say that life cannot guide material processes unless it is itself a form of energy (which is false; a man is not a form of energy)—those who hold that life cannot, in fact, act at all unless energy is at its disposal (which is certainly true)—forget the apparently spontaneous activity of complex organised molecules, forget the atomic disintegration manifested by radio-activity. Energy is not a guiding or controlling entity at all. It is a thing to be guided. Energy by itself is as blind and blundering as a house on fire, or a motor car without a driver.

"There is a great difference, moreover, between matter potentially living and actually alive. It must never be forgotten that in the physical universe our power is limited to the movement of matter: all that happens, after that, is due to the properties of matter and of its ethereal environment. If potentially living matter is ever artificially produced, by placing things in juxtaposition and bringing natural physical resources to bear upon the assemblage—which is all that we can do—then it may become alive. But if this last step is taken, it will be because something beyond matter, and outside the region of physics and chemistry, has stepped in and utilised the material aggregate provided—in the same way, presumably, as that in which it now steps in and utilises the material provided, say, in an egg or a seed. That is my belief, and only in that sense do I anticipate that the artificial incarnation of life will ever be possible. Certainly life has appeared on the earth somehow, and some day it may perhaps appear under observation. In that case it will be said to have been manufactured. It will be manufactured just as much as radium or radio-activity has been manufactured, and no more."

TRANSVAALIA; A NEW PLANET.—It is announced that Planet 1911 LX, found at the Union Observatory, has received the permanent number 715, and has been named Transvaalia (Astr. Nachrichten, No. 4607).

THE FORMATION OF CHEMICAL COMPOUNDS IN HOMOGENEOUS LIQUID SYSTEMS: A CONTRIBUTION TO THE THEORY OF CONCENTRATED SOLUTIONS.

By Prof. Robert Beckett Denison, M.A., D.Sc., Ph.D.

The question whether chemical combination between two liquids can be detected, and, if so, whether the formula of the compound formed can be obtained from a consideration of the physical properties of mixtures of the two liquids, is probably one of the most controversial points in the whole of theoretical chemistry. At the same time, it is an exceedingly important question, since, if it can be answered in the affirmative, we are at once in the possession of a simple method of determining the formulæ of compounds in solution without their isolation being necessary.

With regard to the physical properties of gaseous mixtures, it is well known that the simple mixture law is generally obeyed. That is, for all mixtures of two gases from 0 to 100 per cent. of either constituent, the value of any physical property is intermediate between, and lies on a straight line joining the values of the physical property for the two pure gases.

Taking as example the density of mixtures of oxygen and nitrogen, we have roughly $O=16$ and $N=14$ $(H=1)$. Plotting the fractional composition by volume as abscissa, and the density as ordinate, then the densities o fall mixtures of nitrogen and oxygen lie on the straight line NO. It is almost unnecessary to point out that in order to obtain this straight line relationship in general, the composition must be expressed as fractional composition by volume when the physical property has volume in the denominator, *e.g.*,

$$\frac{\text{mass}}{\text{volume}}=\text{density}.$$

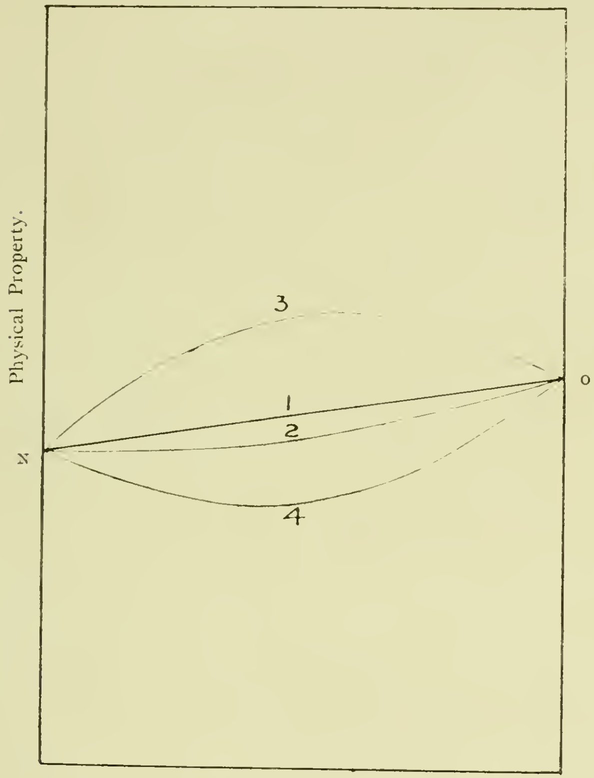
Conversely, composition must be expressed by weight if the property has weight in the denominator, *e.g.*,

Specific volume=the volume of unit weight.

Instead of plotting the fractional composition by volume, we can replace it by the fractional number of molecules, since in the case of gases Avogadro's hypothesis holds good. In short, the specific gravity-composition curve of a gaseous mixture is a straight line whether the composition be plotted as molar-fraction or as fractional composition by volume.

This simple form of what we will term property-composition curves is not shown by binary liquid mixtures, except in rare instances. The usual forms are depicted in Fig. 1, curves 2, 3 and 4.

If mixtures of two given liquids are found to obey the straight line law, then by analogy with gaseous mixtures we conclude that the molecules of the two components are in the same state after mixing, as before. If, however, the property-composition curve is "sagged" or otherwise different from a straight line, then some molecular change must have taken place on mixing. To fix our ideas, let us consider the density-composition curve of a mixture of two liquids. If the curve is always below the straight line, *i.e.*, the density always less than its theoretical



Composition of mixture.

Fig. 1.

value, the usual explanation is that dissociation of one of the components has taken place. Similarly, if the density were always greater than the theoretical value as deduced from the law of mixtures, this would generally be taken to indicate the association of the molecules of one of the liquids. In short, the only deductions that one can make from these curves are in general deductions by analogy with the better-known gaseous systems. The occurrence of a maximum in the property-composition curve has usually been taken to represent chemical combination between the two liquids. There seems to be no direct foundation for this assumption, since, as far as I know, no analogous gaseous system has been completely studied. There is, however, a fair amount of evidence that the conclusion is correct. It is found to be almost invariably the case that those liquid mixtures which give a maximum in the property-concentration curve are formed with evolution of heat and contraction in volume. Moreover, it is often, but by no means always, the case that the maximum occurs at a definite molecular composition of the mixture, *i.e.*, at a mixture representing simple molecular proportions of the components. Naturally, then, there has been a tendency to take this composition as the formula of the compound in solution. So often does this method of deducing the formulæ of hypothetical compounds in solution appear in chemical and physical literature that it cannot be too clearly pointed out that the method is purely arbitrary, and rests on no scientific foundation. Again, the composition of the mixture corresponding to the maximum in the curve very often varies with temperature. This had to be explained by another assumption, *viz.*, that the compound undergoes dissociation to a greater or less extent depending on the temperature. Owing to the number of assumptions which have to be made in order to arrive at the formula of a compound in solution on these lines, most chemists have abandoned the method as too unsatisfactory for use. The recognition of the weakness of this method has tended to throw very considerable doubt on the possibility of arriving at the formulæ of compounds in solution, or even of deducing their presence by a study of the physical properties of mixtures. Washburn, in a recent review, sums up the question as follows:—

"We are therefore forced to conclude, in spite of the extensive literature on this phase of the subject, that methods of studying hydration (*i.e.*, combination in aqueous solution) which depend upon the deviations of any physical property of a solution from the law of mixtures are incapable of yielding any conclusive information regarding the complexity or even the existence of hydrates in aqueous solution."

In spite, however, of this seemingly logical conclusion, it is found that on reviewing the cases where a maximum occurs in the property-composition curve, the number of mixtures, which exhibit the maximum at or very near a composition representing a simple molecular proportion of the two components is too great to be fortuitous. There appear to be some possibilities in the method as a means of deducing combination in solution, but before these can be realised it is essential to remove some of the arbitrary character of the method, and place it in a nearer relationship to the established principles of chemistry. This seems to me to be quite possible.

If chemical combination takes place when two liquids are mixed, then the mixture consists of at least three kinds of molecules, *viz.*, pure A, pure B, and pure compound, which we will denote by AB. As the proportions of A and B are altered, the amounts of AB formed must vary according to the law governing homogeneous equilibria, namely, the law of mass action.

It may be objected that A and B may form a number of compounds in solution, such as AB, AB_2, AB_3, ... Such a supposition gives us, of course (with regard to aqueous solutions), the older hydrate theory of Mendeléef, Pickering, and others.

It seems to be that the theory of an indefinite number of hydrates or similar compounds in equilibrium with the two components is very improbable. Each such hydrate will have a definite dissociation tension which varies with the temperature, pressure, and its concentration. The aqueous vapour tension of the hydrate must be in equilibrium with the total aqueous vapour pressure of the system, and if the dissociation pressures of the different hydrates differ widely, as one would expect, then their amounts (in the presence of the two components) must also differ very widely. Thus, in the presence of the two components, A and B, one compound must at any rate very largely predominate. The matter becomes clearer if we consider an analogous gaseous equilibrium. Imagine a mixture of nitrogen and oxygen at such a temperature that true equilibrium is possible. Such a condition is easily attainable in practice, and the system has been the subject of considerable experimental study. It is not found to be possible for all the oxides of nitrogen to exist simultaneously in equilibrium with the two components N_2 and O_2, nor would any chemist expect this from *a priori* considerations. We can, of course, obtain systems consisting of N_2, O_2 and NO or NO, O_2, and NO_2, or NO_2, O_2 and N_2O_5 in equilibrium according to the conditions of temperature and pressure. The reasons why the various oxides cannot simultaneously co-exist in equilibrium with the two components is that the different compounds have widely varying energy contents. In other words, the dissociation tendencies of the various oxides are so very different that their co-existence in the presence of N_2 and O_2 is impossible except in infinitely small amounts. One compound largely predominates, but which one it is depends upon the conditions. Should one of the components disappear, then another compound may be formed, and we may thus have NO, NO_2 and O_2 in equilibrium. Again, the amounts of each will so adjust themselves that their oxygen dissociation pressures are in equilibrium with the total oxygen pressure of the system.

Whether any flaw be found in this reasoning or not, the fact remains that if we allow the co-existence of any number of hydrates or similar compounds in a homogeneous liquid system in the presence of the two components, then the system becomes incapable of mathematical treatment on the lines of the law of mass action, and no quantitative theory of solution is likely on such a basis. To my mind this is precisely the weakness of the

Mendeléef-Pickering hydrate theory of solution. If, however, one compound largely predominates in solution, then the law of mass action can be applied with some success.

The application of the law of mass action to the system under discussion gives the relationship at constant temperature:

$$\begin{bmatrix}\text{Active mass of } A \\ \text{in equilibrium}\end{bmatrix} \times \begin{bmatrix}\text{Active mass of } B \\ \text{in equilibrium}\end{bmatrix}^n = \text{a constant} \times \begin{bmatrix}\text{Active mass of} \\ AB_n \text{ in equil.}\end{bmatrix}$$

It would seem necessary, in discussing matters relating to concentrated solutions, to define what one means by "active mass." This quantity is generally represented by "concentration," *i.e.*, by so many gram-molecules or mols per unit volume.

Now one's definition of "active mass" must depend somewhat on how one defines an ideal solution.

As is well known, Van 't Hoff has defined his ideal *dilute* solution as one which obeys the gas laws

$$pv = nRT,$$

with the substitution of osmotic pressure for gaseous pressure. But even the gas laws in this simple form are quite invalid at moderate pressures, *i.e.*, at moderate concentrations, and have the necessity of a new general definition of a solution which shall cover both dilute and concentrated solutions. In this paper I propose to take as my ideal solution one which obeys the mixture law throughout the range of its composition.

If, then, we have a homogeneous mixture of y mols A and $(1-y)$ mols B, and there is no molecular change on mixing (*i.e.*, we have an ideal binary mixture or solution), then the value of any molecular property for the mixture is given by

$$X_M = \beta_1 x_1 + \beta_2 x_2$$

where x_1 and x_2 are the values of the given property for pure A and pure B respectively, and
β_1 and β_2 are the molar fractions of A and B in the mixture.

β_1 thus represents the fraction of any attribute of the mixture which is due to the presence of A, and β_2 represents the same for the liquid B.

β_1 and β_2 I take as the "active masses" of A and B respectively.

In the case of mixtures of gases and in dilute solution this conception of active mass coincides with the older one of mols per unit volume, but with liquid mixtures throughout their range of composition this is no longer the case, owing to the fact that the two liquids A and B have different specific and molecular volumes.

Returning now to the case where A and B form a compound ABn, let us imagine the mixture formed from y mols A and $(1-y)$ mols B. If no combination or other molecular change takes place, the total number of mols present is unity. If, however x mols of compound ABn be formed,, then we have in the equilibrium

$$\left.\begin{array}{ll} (y - x) & \text{mols A} \\ (1 - y - nx) & \text{mols B} \\ x & \text{mols } AB_n \end{array}\right\} \text{total mols } (1 - nx)$$

Taking active mass as proportional to molar fraction we have for the expression of the mass law

$$\frac{(y - x)}{1 - nx} \times \left(\frac{1 - y - nx}{1 - nx}\right)^n = \frac{Kx}{1 - nx}$$

where K is the equilibrium constant for a given constant temperature.

$$i.e., \ (y - x)(1 - y - nx)^n = Kx(1 - nx)^n$$

This expression governs the relation between the amounts of A, B, and ABn in the solution as the composition varies from 100% A to 100% total B.

When $\quad y = \dfrac{1}{n + 1} \qquad \dfrac{dx}{dy} = 0$

and x has a maximum value.

Hence the composition of the solution or mixture at which the amount of compound is a maximum gives n *i.e.* the formula of the compound formed.

Further if $n = 1$, that is, the formula of the compound is AB, then the molar fraction of A in the true compound is

$$0.5 \qquad i.e. \qquad \frac{1}{n + 1}$$

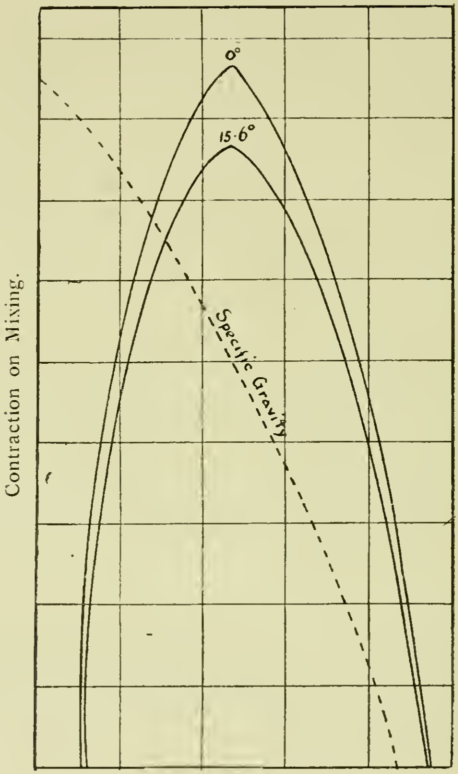
In short the composition of the mixture which contains the maximum amount of the compound is also the composition of the compound formed. This is quite independent of the degree of dissociation of the compound, since the expression for maximum amount of compound

$$y = \frac{1}{n + 1}$$

is independent of the value of the equilibrium constant K.

This result might be foreseen from the following consideration. Suppose we have the compound ABn, which, however, is more or less dissociated. If we add to it excess of the component A we are performing two distinct operations, each of which affects the equilibrium. Firstly, we are decreasing the degree of dissociation of the compound according to the principle of mass action, but secondly we are also decreasing the active mass or concentration of the constituent B, and also increasing the volume of the system or the total number of mols present This tends to increase the degree of dissociation of the compound. The second process has much the greater effect, and hence addition of either excess A or excess B lowers the active mass of the compound. Hence the concentration or active mass of the compound ought to be a maximum when the solution has the same percentage composition as the compound itself.

It has been shown that this result is obtained easily from the law of mass action if active mass be taken as equivalent to molar fraction. It is not thus obtainable if active mass be



Percentage of alcohol by weight.
Fig. 2.

expressed as mols per unit volume, because in the appropriate mass law expression

$$(y - x)(1 - y - nx)^n = KV^n x^n$$

there are three variables x, y, and V.

I have, however, already shown† that in a binary mixture where chemical combination occurs between the components, the

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* For the representation of active mass by molar fraction see also G. N. Lewis: *J. Amer. Chem. Soc.*, 1908, and Dolezalek: *Zeit. Physik. Chemie*, 1908.

† Faraday Soc. Trans 1912.

deviation of the property-composition curve from the straight line is proportional to the amount of compound formed.

Hence the maximum deviation of the property-composition curve from the straight line must occur at that composition of the mixture which gives the composition of the compound formed.

In order then to decide whether chemical combination occurs on mixing two liquids, it is sufficient to determine the value of the specific or molecular volume, refractive index, optical rotation, etc., for mixtures of various compositions, and find at what composition the deviation from the straight line is a maximum.

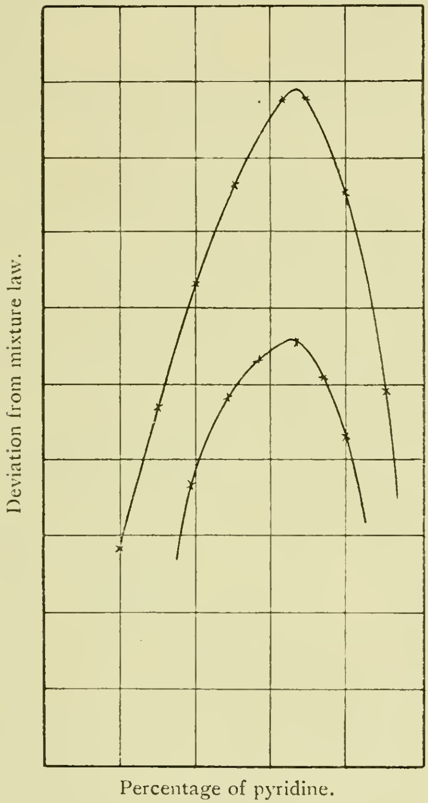

Fig. 3.

Numerous examples could be given to show the applicability of this deduction. At present I will confine myself to very few.

In Fig. 2 are plotted the deviations from the mixture law of ethyl-alcohol—water mixtures as regards specific volume. The actual experimental figures are not given, but are to be found in the transactions of the Faraday Society, 1912, where a somewhat more detailed discussion of this subject is given. A sharp maximum in the deviation curve occurs at 46% alcohol.

$$C_2H_6O.\ 3H_2O = 46\%\ \text{alcohol}.$$

The viscosity deviation curve also gives a maximum at 46%.

Similarly Fig. 3 gives the contraction on mixing and the viscosity deviation from the mixture law for mixtures of pyridine and water. A maximum deviation occurs at 68.5% pyridine.

$$C_5H_5N.\ 2H_2O = 68{\cdot}6\%.$$

In Fig. 4 are plotted the actual viscosity-composition curves and the deviation curves for mixtures of benzene, acetic acid and lactic acid—water.

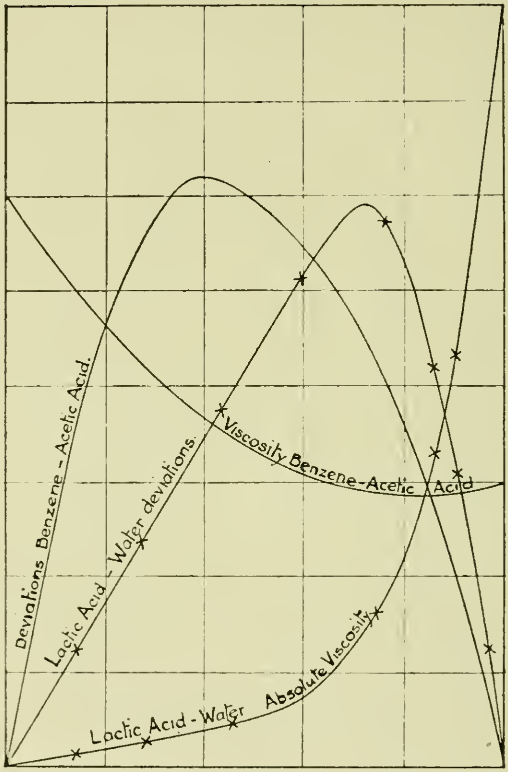

Fig. 4.

The actual viscosity-composition gives no indication of the formation of a compound, but maximum deviation from the mixture law occurs at 39.5% benzene and 72% lactic acid respectively.

$$C_6H_6.\ 2C_2H_3O_2 = 39{\cdot}4\%\ \text{benzene}$$
$$C_3H_6O_3.\ 2H_2O = 71{\cdot}5\%\ \text{lactic acid.}$$

In all these cases maximum deviation occurs at a composition which represents as exactly as experimental accuracy permits simple molecular relationships between the constituents of the mixture.

The effect of temperature change on property-composition and on deviation-composition curves.

It has been frequently observed that when the property composition curve for a binary mixture exhibits a maximum, the composition at which this maximum occurs is not fixed, but changes with temperature alteration. It has been pointed out that it was this fact which has led many chemists to reject the idea of determining the presence of compounds in solution from a study of such property-composition curves. Such an attitude is, of course, correct, since one cannot imagine a compound which changes its actual composition gradually with change of temperature.

Now from what has been already said, it is evident that the actual form of the property-composition curve for a given binary

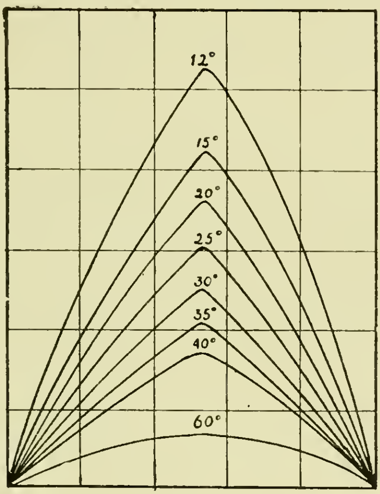

Fig. 5.

mixture wherein chemical combination has taken place depends on the relative amounts of the three molecular species present, and also on the separate properties of these. Change of temperature will almost always alter the equilibrium constant K, that is, K will alter the relative amounts of A, B, and ABn in the system. Moreover each molecular species has its own temperature co-efficient for any physical property, and therefore it is only to be expected that change of temperature will alter the position of, and may even cause the disappearance of a maximum in the actual property-composition curve. It is, however, quite different with the deviation curve, *i.e.*, the curve obtained by plotting the deviations from the mixture law against the composition of the mixture. The *position* of maximum deviation depends only on the formula of the compound formed, and is independent of the degree of dissociation. The formula of a compound cannot change gradually with temperature, and hence the deviation curve at different temperatures must show a maximum in exactly the same position. A confirmation of thi deduction is seen in Fig. 5, which gives the viscosity deviation curves for methyl alcohol—water mixtures at various temperatures. The deviations become less as the temperature is increased. This indicates that the amount of compound formed is less at higher temperatures. Hence, again, the compound dissociates on raising the temperature, and consequently the formation of the compound must generate heat. As is well known, the mixing of alcohol and water evolves a considerable amount of heat.

It is evident, however, that the position of maximum deviation is quite independent of temperature, as theory demands.

This should remove one of the great difficulties in the acceptance of the principle of deducing the formation of compounds in binary mixtures from a study of their physical properties.

The evaluation of the dissociation constant K.

The best test of any theory is to be found not merely in qualitative but in the quantitative agreement of experiment with the deductions from the theory. Further, in all cases of combination in homogeneous systems, including hydrate formation and dissociation, the great desideratum is, of course, the numerical value of the dissociation constant. This is often impossible to determine by ordinary methods. It would seem that the ideas developed in the present paper may offer a partial solution of the problem.

If we have a system composed of y mols total A and $(1-y)$ mols total B and x mols of a compound ABn are formed, then the equilibrium is governed by the relationship

$$(y - x)(1 - y - nx)^n = KV^n x$$

if active mass be taken as mols per unit volume, or

$$(y - x)(1 - y - nx)^n = Kx(1 - nx)^n$$

if we put the active mass equal to the fraction of the total number of mols present.

Since the deviation from the straight line (δ) is proportional to the number of mols of compound formed we have

$$x = p\delta$$

Substituting for x we obtain

$$(y - p\delta)(1 - y - np\delta)^n = Kp\delta V^n$$

and for another value of y

$$(y - p\delta_1)(1 - y_1 - np\delta_1)^n = Kp\delta_1 V_1^n$$

In these equations everything is known except p and K. By eliminating the one we obtain, of course, the value of the other.

If n is greater than one, as is usually the case, the solving of these equations is very laborious. I have been unable to find accurate numbers for a binary mixture with chemical combination where $n = 1$. By extending the principle of this paper we can, however, test the results by some accurate data in regard to electrolytes.

The volume changes which occur on mixing liquids have been studied by Holmes and Sageman.*

These authors attribute such changes to purely physical molecular processes on mixing. They come to the conclusion that chemical combination in solution is unnecessary to explain the deviations of binary mixtures from the simple mixture law. and they point out that their interpretation of the facts is totally incompatible with any "hydrate" theory of solution. Furthermore, their theory leads them to the remarkable conclusion that there is no chemical combination, *i.e.*, no formation of bisulphate when sulphuric acid and normal sulphates are mixed in aqueous solution. This conclusion is difficult to reconcile with the fact that bisulphates can be obtained from the solution, since a substance cannot crystallise from a solution which does not contain it. The actual amount in solution it is true may be small, but it must be finite. However, the electrolysis of bisulphate solutions would appear to show that the amount of bisulphate present as such is considerable. I propose to show that the accurate experimental figures of the above authors afford excellent quantitative evidence of the formation of bisulphate if viewed from the standpoint of mass action. Incidentally they serve as a test of the theory put forward by the present author.

Let us assume then that the formation of bisulphate takes place on mixing solutions of H_2SO_4 and K_2SO_4 according to the equation

$$H_2SO_4 + K_2SO_4 = 2KHSO_4$$

Neglecting ionisation (which makes but little difference in the present case), and considering only unionised molecules, let us further suppose that in a mixture of y mols K_2SO_4 and $(1-y)$ mols H_2SO_4 there are formed $2x$ mols $KHSO_4$.

The system then consists of

$$\left.\begin{array}{lll} (y - x) & \text{mols free} & K_2SO_4 \\ (1 - y - x) & \text{,,} \quad \text{,,} & H_2SO_4 \\ 2x & \text{,,} \quad \text{,,} & KHSO_4 \end{array}\right\} \text{total } 1$$

Hence according to the law of mass action we have

$$(y - x)(1 - y - x) = Kx^2$$

* *J. C. S.*, Trans., 1906, vol. 89, p. 1174.
J. C. S., Trans., 1907, vol. 91, p. 1606.

Owing to the fact that there are equal numbers of mols on each side of the equation the volume of the system has, of course, no effect on the equilibrium.

Differentiating with respect to y we find that the number of mols and the active mass of bisulphate in the system is a maximum when $y = \frac{1}{2}$, *i.e.*, when the system as a whole contains equal molecular amounts of the two components.

But on our theory x is proportional to the contraction on mixing, and hence this contraction should reach a maximum value at the composition $y = \frac{1}{2}$. It is evident from the curves shown in Fig. 6 (taken from Holmes's paper) that this is very exactly the case.

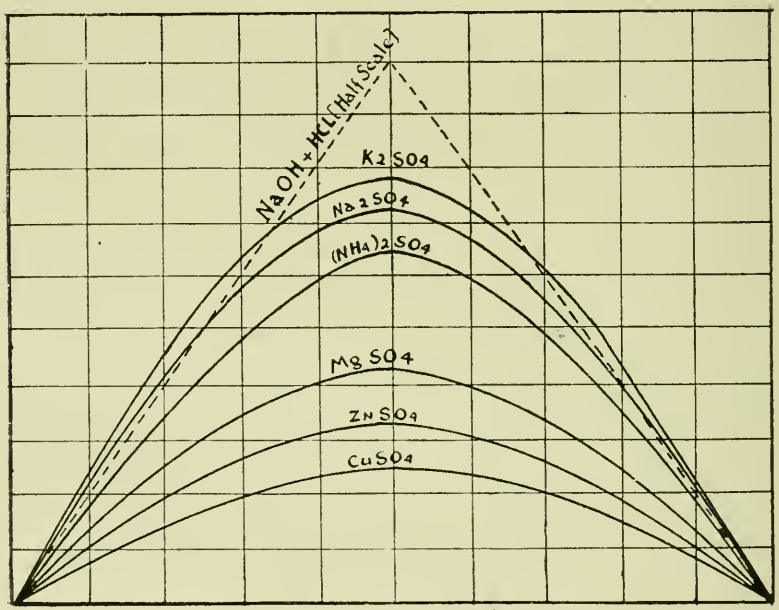

Fig. 6.

From the equation $(y - x)(1 - y - x) = Kx^2$, we see that when K approaches zero, *i.e.*, total combination between the components, $(y - x)(1 - y - x) = 0$.

The relation between x and y is then represented by two straight lines equally inclined to the composition axis and meeting at a point whose abscissa is given by $y = \frac{1}{2}$.

This is exactly the case given by Holmes for solutions of HCl and NaOH, where combination is, of course, practically complete. When combination is not complete, *i.e.*, the compound formed is more or less dissociated, the straight lines become curves, and instead of a point maximum where two straight lines meet, we get a smooth curve with a more or less pronounced maximum. Hence the flattening of the curve at the maximum must give a rough measure of the stability of the compound formed. But the relative stability of a series of acid salts in the presence of excess of water should be proportional to the "strength" of the different bases. Hence the order of stability of the bisulphates should be $KHSO_4$, $NaHSO_4$, NH_4HSO_4, $Mg(HSO_4)_2$, $Zn(HSO_4)_2$, $Cu(HSO_4)_2$. It will be observed that this is precisely the order of stability as deduced from the curves given by Holmes and Sageman. [See Fig. 6.]

Putting the number of mols of bisulphate proportional to the expansion (δ), on mixing we have

$$x = p\,\delta$$

and substituting in the mass action equation for x we obtain

For $y = 0.25$ $(0.25-.269\,p)\,(0.75-.269\,p) = K\times(0.269)^2p_2$

For $y = 0.5$ $(0.5-.394\,p)\,(.5-.394\,p) = K\times(0.394)^2p^2$

From these two equations $p = 0.82$

Similarly the experimental expansions for other values of y can be used to obtain a value of p. Were there no experimental errors p would always have the same value. The value of p as deduced from all the measurements given for the system under consideration is not quite constant, but very nearly so. The mean value of p is very near

$$p = 0.80$$

Substituting for p we obtain the following values for K:—

$y =$	0.2	0.25	0.33	0.5	0.67	0.75
$K =$	0.29	0.40	0.34	0.34	0.32	0.29

Mean $K = 0.33$.

When one considers the cumulative effect of any experimental error on the value of K the constancy attained above is quite satisfactory. It shows that the process causing the expansion on mixing, whatever its nature, is governed by the law of mass action in the form set down.

Taking the mean value of K, and re-calculating x for the different mixtures, we obtain the following numbers:—

Fraction mols K_2SO_4 in the mixture y	Fraction mols $KHSO_4$ x	Calculated Expansion $= x$ multiplied by $\frac{39400}{316}$	Holmes' experimental value for the Expansion on mixing.
0·2	·182	227	230
0·25	·220	274	269
0·33	·270	337	338
0·50	·316	394	394
0·67	·271	340	340

The numbers in the third column are the values of the amount of bisulphate in solution multiplied by a constant so as to convert one of them into the actual experimental expansions given by Holmes and Sageman. If the formation of bisulphate can account for the volume changes on mixing, these calculated expansions should agree with the experimental ones. It is evident that the agreement is an excellent one.

These calculations show, moreover, that the theory of binary mixtures developed by the author of the present paper is applicable to the investigation of equilibria in ternary liquid systems when one component is in large excess.

The method of evaluating p and x given above may become rather laborious, and, moreover, needs very accurate experimental data in order to give anything like constant values for p. A much shorter but somewhat less accurate method of obtaining the same result is given below.

From the mass action equation $(y-x)\ (1-y-x) = Kx^2$ we have seen that when chemical combination is practically complete the relation between x and y is given by two straight lines equally inclined to the axes. These straight lines meeting at the point $y = \frac{1}{2}\ x = \frac{1}{2}$ are the tangents to the extremities of the deviation curve, *i.e.*, tangents at the points $y = 0$ and $y = 1$. If chemical combination is not complete then the curve giving the relation between x and y has a maximum at $y = \frac{1}{2}$, but the corresponding x value is less than one half. Since the deviation is proportional to x, we have the relationship

$$\frac{\text{actual value of } x}{\frac{1}{2}} = \frac{\text{actual distance of maximum in deviation curve above } y \text{ axis}}{\text{actual distance of point where tangents meet above } y \text{ axis.}}$$

$$(y = \tfrac{1}{2})$$

By plotting the experimental expansions for the system $K_2SO_4 - H_2SO_4$ on a large scale, it is found that the tangents to the curve at the points $y = 0$ and $y = 1$ meet at a point $x = 630$ when the maximum experimental expansion is 394. There is, of course, a considerable degree of uncertainty in the estimation of this point; hence the probable inaccuracy of the result.

In the case before us we see then that if combination were complete ($x = \frac{1}{2}$), the measured expansion would be 630 units.

Hence $\dfrac{x}{\frac{1}{2}} = \dfrac{394}{630}$

$$x = 0{\cdot}313$$

$$p = 0{\cdot}79.$$

The values previously obtained by solving the separate equations for p and x were $x = .316$, $p = .80$.

The agreement in this case is much better than is likely to be obtained as a general rule.

It shows that in any case this geometrical method of evaluating x and K gives at least approximately correct results.

SUMMARY.

The main results of the present research are as follows:—

1. Taking an ideal mixture as one which obeys the mixture law, then the property-composition curve itself can in general afford very little evidence of the formation of a compound between the two components of the mixture. The curve obtained by plotting the deviations from the straight line against the composition of the mixture is, however, of considerable importance.

2. The deviation from the straight line is proportional to the amount of compound formed.

3. The active mass of the compound is a maximum when the mixture as a whole has the same composition as the compound formed.

4. It is possible to determine the formula and the degree of dissociation of a compound formed in a liquid system from a consideration of physical data alone.

5. Although temperature changes may affect the form of the property-composition curve, especially as regards the position of a maximum therein, the position of maximum deviation from the straight line is independent of temperature change.

6. The principles stated above have been applied in the investigation of the equilibrium

$$K_2SO_4 + H_2SO_4 = 2KHSO_4$$

in aqueous solution.

A NEW VEGETABLE OIL.—In No. 134 of the *Journal d'Agriculture Tropicale*, pp. 233-234, C. de Mello Géraldès describes an oil from Mozambique, obtained from the fruit of *Trachylobium*, sp., which contains an average of 12.48%. From its chemical and physical constants, and the fact of its being half drying, it may be grouped with cotton seed oil. It seems suitable for soap manufacture, and is valued at 5d. per lb.

ELECTROLYSIS OF WATER WITH CARBON ELECTRODES.

By Edward Godfrey Bryant, B.A., B.Sc.

It has been known for many years that when graphite is treated for several days, with a mixture of nitric acid and sulphuric acid or some other powerful oxidising mixture, at a gentle heat, it is partly converted into a substance known as graphitic acid ($C_{11}H_4O_5$) This substance forms pale yellow crystalline plates, somewhat soluble in water, and the solution has an acid reaction, reddens litmus, and combines with bases. Under the same conditions charcoal is converted into a brown soluble substance of unknown or indefinite composition. Berthelot proposed to found upon this a method for estimating the amounts of charcoal and graphite respectively in any sample of carbon.

The object of this paper is to describe an entirely different method of preparing the above compounds or others very similar to them, for I have had no means of *proving* that the compounds prepared by me have precisely the same composition as graphitic acid. If a high tension current is passed between two pieces of carbon placed in a vessel of water, the water soon begins to acquire a brown tint and to become a fairly good conductor. This occurs even in distilled water, though the action is then extremely slow, and many hours elapse before any appreciable action begins. The negative carbon is entirely unaffected, while the anode is gradually used up; fragments are torn off from it and collect at the bottom of the vessel. The amount of oxygen given off at the anode is notably less than it should be as compared with the hydrogen.

In my experiments a voltage of 250 was used and the current, inappreciable at first, gradually rose to an apparent maximum of about $\frac{1}{10}$ ampère per sq. inch of carbon surface, the carbon poles being 2 to 3 inches apart. After 24 hours the chemical action on the carbon almost ceased, judging from the colour of the solution, which remained practically stationary after that period. If the current was now stopped and the positive carbon placed in fresh water the brown compound could be dissolved out of it in small quantity for days afterwards, seeming to show that it had been formed right inside the carbon itself and formed, too, more quickly than the water could dissolve it.

The first trial was made on electric light carbons, which had been placed in a vessel of water for the purpose of forming a simple resistance arrangement. In order to ascertain whether the substance thus formed was really due to electrical action between carbon and water, two hard battery carbons were next tried with precisely similar result. Afterwards gas carbon, pure graphite, and wood charcoal were tried, and all were acted upon, though not to the same extent.

The strongest solution obtained was practically opaque with a thickness of 1 to 2 cms., yet contained only .16 per cent. of solid matter. A resinous black mass was obtained on evaporation; this easily redissolved in water. The solution was acid to litmus. The solid can be precipitated by salts, strong acids, and alkalies as an amorphous mass very difficult to filter. The solution has thus very distinctly colloidal properties. After precipitation of the brown solid by neutral salts the liquid remains distinctly coloured and has a more acid reaction than before.

This fact, with other indications, convinced me that there were at least two substances present, both containing very high percentages of carbon. A slight rise of temperature above 100°C. converts them into insoluble substances with a loss of weight of approximately 30 per cent. If this black residue is ignited a slight but distinct smell of burnt sugar is evolved with a small quantity of white fumes. As mentioned above, gas carbon, battery carbon, and other dense forms all gave rise to similar results. When wood charcoal was tried, the usual brown solution resulted, but this solution was neutral to litmus. With graphite a pale yellowish solution was obtained having acid properties. I have not had time to carry the experiments further, but it would seem fairly certain, combining my results with the earlier ones of Berthelot and others that under the conditions of the experiments I have carried out graphite yields graphitic acid only, and charcoal a brown substance, or mixture of substances; while all the denser forms of carbon yield a mixture of the two. It would further follow that graphite must be a constituent of these more refractory varieties.

Owing to lack of time I have not yet been able to put forward any very definite results, yet the method of procedure described appears to promise interesting results if carried out in a thoroughly efficient manner. The action of high tension electricity in the formation of carbon compounds seems to have been little studied up to the present, and yet it appears to approach more nearly to natural methods than any other. There is little actual expenditure of energy; there are no violent changes of temperature or powerful reagents used. In the animal or vegetable cell the most elaborate compounds are built up step by step from simple ingredients with the aid of the energy of the sun's light and heat. I believe I am correct in stating that though the actual energy consumed in the cell is infinitesimal yet there may be relatively enormous potential differences between the various contiguous molecules present, and in this difference of potential energy is to be found one of the chief agents engaged in the elaboration of the more complex cell products. If this is so, then, we can most nearly imitate the natural processes by employing similar differences of potential energy in our own work. The products obtained by such means will be prepared in small amounts only; the chief difficulty will perhaps be found in separating and identifying substances formed only in microscopical quantity, and for those purposes the most refined methods of analysis must be employed.

TRANSACTIONS OF SOCIETIES.

Royal Society of South Africa.—Wednesday, October 16th: Dr. L. Péringuey, F.E.S., F.Z.S., President, in the chair.—"Note on double alternants": Dr. T. **Muir.**—"*Xenopus laevis* (the Plathander)": Dr. T. F. **Dreyer.**—"A short note on the occurrence of Aspergillosis in the Ostrich in South Africa": J. **Walker.** The author believes Aspergillosis to be the cause of considerable mortality in ostrich chicks, and, to a less extent, in adults, the seat of lesions being principally the lungs.—"A preliminary survey of the meteorology of Kimberley": Dr. J. R. **Sutton.** Statistics and tables were given showing the principal meteorological elements of Kenilworth (Kimberley), all of which, except the rainfall, are expressed in deviations from the normal monthly means of a period covering 15 years.—"Some geodetic elements": C. **Moorsom.**—"South African Oligochaeta, Part I: on a Phreodrilid from Stellenbosch Mountain": Prof. E. J. **Goddard** and D. E. **Malan.** The paper dealt with the anatomy of a new genus, *Gondwanaedrilus*, constituting the first record of the family in Africa. The occurrence of this genus in Africa completes in detail the circumpolar distribution of the family.—"Contributions to a knowledge of South African Oligochaeta Part II. Description of a new species of Phreodrilus": Prof. E. J. **Goddard** and D. E. **Malan.** The new species, which is definitely related to *P. beddardi* and *P. subterraneus*, was found on Table Mountain in August.—"Contributions to knowledge of South African Hirudinea, Part II: on some points in the anatomy of *Marsupiodella africana*": Prof. E. J. **Goddard** and D. E. **Malan.** An account was given of the anatomy of a new Glossiphonid leech with a large internal brood pouch.—"Portuguese commemorative pillars erected on the South African coast": Dr. L. **Peringuey.** During the reign of John II. of Portugal, Portuguese navigators sailed for the first time provided with commemorative pillars to mark the progress of their journey. Diogo Cam was the first to leave Portugal with these pillars. Historians attribute to him the erection of three, the most southern of which, at Cape Cross, was discovered in 1893. Chroniclers are not clear about the number of pillars erected by Dias, and hitherto three only have been mentioned, whereas it would appear that he put up five: The first was erected at Angra Pequena in November, 1487; ten days later, the navigator reached Angra das Voltas, and erected another pillar; in February, 1488, he reached Algoa Bay and set a third pillar on a small island; after that he reached the River Rio Infante, but was compelled to return by his crew; he retraced his way to Algoa Bay, and erected a fourth pillar on Cape Padron, to the east of the bay; he discovered the Cape of Good Hope and erected a fifth pillar, probably at Cape Point. Of all these pillars two only are now known to be in existence, Cam's pillar at Cape Cross, and a fragment of the pillar from Angra Pequena is in the Cape Museum. The author called attention to the possibility of finding some remnants of the others. It is reported that at the mouth of the Orange River, where Dias abandoned his store ship with nine men, and on his return found one survivor only, who expired at the sight of his countrymen, rock gravings reproducing crucifixion scenes have been seen.

South African Institution of Engineers.—Saturday, November 9th: Mr. J. A. Yule, President, in the chair.—"South African corundum and its uses": J. **Broad-Roberts.** Reference was made to occurrences of corundum near the Olifants River at Malalane and west of the Mashishimali Range in the Transvaal. Attention was drawn to the corundum industry in Canada, and to the various uses of the article, the only opening for its use in South Africa at present appearing to be as lining for tube mills.

PRELIMINARY LIST OF FLOWERING PLANTS, FERNS AND FERN ALLIES, FOUND IN THE PORT ELIZABETH DISTRICT.

By Isaac Louis Drège.

At the request of some friends I have been induced to bring forward a list of plants of the district of Port Elizabeth, Cape of Good Hope. The Port Elizabeth municipal area is bounded on the south by a line from the sea, drawn through the Roman rock beacons, to the south-east corner of Walmer farm; thence in a northerly direction along the east boundary of the said farm to the north-east corner of the same; thence westward along the Walmer boundary to the beacon next Harris's Kraal; thence in a north-easterly direction along the boundaries of Newcombe's farm and Korsten, to the northward of the north creek; thence following the line of the Deal Party's grant, to the sea; and thence, along the sea beach at high-water mark, to the first-mentioned point. The area of Port Elizabeth *Municipality* is about 15 square miles. The *district* of Port Elizabeth is about 300 square miles in extent. The district extends from Sea View farm to Green bushes, from Green bushes to Redhouse, from there along the Zwartkops river to the sea. The Port Elizabeth district is bounded by the Uitenhage district and the sea. Most of the plants have been found by myself, and by recording the finds I have been able in most cases to give the month for flowering. Although the district is small the number of plants is not disappointing (over 500). I have tried to make this list as complete as possible, but there is still much room for improvement, especially amongst the cryptogams, which I think have been rather neglected by botanists. I would like to mention a few of them, and may, by so doing, induce others to follow this up.

ALGAE.

Nitella sp.

FUNGI.

Graphiola Phœnica on Phœnix.
Polyporus sp., found in May.
Agaricus campestris.
Clavaria sp., close to *acuta*, found in April.
Mutinus sp.
Kelchbrennera Tuckii, found in a gravelled yard (once only) in April.

Kalchbrennera Tuckii is strangely distributed. It was originally found in Angola, and then redescribed from a specimen found at Somerset East. Dr. Schönland has had several specimens at various times from Grahamstown, but it seems to be very rare.* The fungus is of a very frail structure, and emits

* Letter from Dr. S. Schönland, 19th April, 1909.

a very unpleasant odour. This specimen was found in Port Elizabeth in a gravelled yard.

Of other plants in my list I would like to mention specially *Viscum minimum* (Laurineæ) on *Euphorbia polygona, Viscum capense* on *Rhus krebsiana* (Terebintineæ), *Eriospermum Drègei* (Liliaceæ), *Drimia haworthioides* (Liliaceæ), *Neodrègea glassii* (Liliaceæ), *Crinum lineare* (Amaryllideæ). *Hexaglottis longifolia* (Iridaceæ), *Angræcum arcuatum* (Orchideæ), *Cytinus dioicus* (Rafflesiaceæ), *Laurentia radicans* (Campanulaceæ), and *Hypoxis aquatica* (Amaryllideæ). Several of these plants may be seen in my garden.

Eriospermum Drègei is a very remarkable plant in particular as to the leaf. Out of a tuber, which is very large in comparison to the leaf, comes the peduncle, about half an inch or less from the ground; it forms a round leaf; the peduncle then grows upwards, and forms a round hairy ball. This ball splits into tree-like branches of a grey colour, covered with long white hairs. These hairs grow from small tubercles like *Mesembryanthemum barbatum* or some cacteæ.

Drimia haworthioides was not suspected to be in Port Elizabeth. The plant has a very curious root, the root underground consisting of onion-like bulb-scale-shaped leaves without chlorophyll, and smaller true roots. These bulb-scale-like leaves afterwards form above the ground the true leaves, which lie flat on the surface. The leaves are produced in February, the flowers in December.

Crinum lineare (Amaryllideæ), *Hexaglottis longifolia* (Irideæ), *Cytinus dioicus* (Rafflesiaceæ), *Hypoxis aquatica* (Amaryllideæ), *Angræcum arcuatum*, *Gethyllis spiralis* and *Hemimeris montana* have not been recorded from Port Elizabeth.

Neodrègea glassii grows in damp places amongst short grass, sheltered by rocks and low bushes of *Erica*, *Passerina*, *Eriocephalus* and *Metalasia*. The name was given by Mr. C. H. Wright at Kew. It belongs to the Liliaceæ. The flower looks very peculiar under a magnifying glass.*

Laurentia radicans Schönland is remarkable on account of its smallness. It is not easy to detect it. It grows flat on the ground in damp places.

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* Letter from Kew referring to this plant:—

"A fruiting specimen of this plant was received at Kew from Mr. James Glass in 1896, but flowers remained unknown until the recent arrival (1909) of Mr. I. L. Drège's specimens from Doctor Schönland, Director of the Albany Museum, Grahamstown. This species has the habit of a dwarf Ornithoglossum, the flower (except the ovary) of Androcymbium, and the ovary of Veratrum, but in the sum of its characters it agrees most with Dipidax. Although the perianth segments are so narrow, yet they bear auricles just above the claw, such as are found more highly developed in the genus Androcymbium, and just indicated in Dipidax. The pistil at first sight appears to be apocarpus on account of the deep lobing of the ovary and the apical divergence of the carpels." Dr. Schönland writes, 23rd September, 1909:—"It is certainly one of the most interesting discoveries made amongst flowering plants in South Africa during recent years."

I must not forget to mention the help I received from Dr. S. Schönland and Mr. Burtt-Davy. Without their aid it would not have been possible for me to make out this list.

5. POLYPODIACEÆ.

Pellæa, Link.

1. *Pellæa hastata* Link.

Adiantum, L.

2. *Adiantum capillus veneris* L.

8. SCHIZÆACEÆ, Diels.

Schizæa.

3. *Schizæa pectinata.*

16a. AROIDEÆ, Brown.

Richardia, Kunth.

4. *Richardia Africana* Kunth, flowers in August.

16b. LEMNACEÆ, N.C. Brown.

Lemna, L.

5. *Lemna minar.*

19. APONOGETONACEÆ, Engl.

Aponogetan, Linn. f.

6. *Aponogeton spartaceum* Hook f. flowers in October.

Triglochin.

7. *Triglochin striatum* Ruiz et Pavon, flowers in October.
8. *Triglochin bulbosum* L. flowers in February.

20. HYDROCHARITACEAE, Ashers.

Lagarosiphon, Harv.

9. *Lagarosiphon muscoides* Harv. flowers in February.

21. GRAMINEÆ.

Andropogon, L.

10. *Andropogon eucomis* Nees, flowers in May.

Setaria, Beauv.

11. *Setaria perennis* Hock, flowers in July.

Tricholæna, Schrad.

12. *Tricholæna setifolia* Stapf, flowers in June.

Pentashistis, Stapf.

13. *Pentashistis viscidula* Nees, flowers in October.

Cynodan, L. C. Rich.

14. *Cynodan Dactylon* Pers, flowers in October.

Eleusine, Gaertn.

15. *Eleusine Indica* Gaertn, flowers in May.

Briza, L.

16. *Briza maxima* L, flowers in October.
17. *Briza minor* L. flowers in October.

22. CYPERACEÆ, J. St. Hill.

Cyperus, Nich.
18. *Cyperus semetrifidus* Schrad, flowers in March.

Mariscus, Gaertn.
19. *Mariscus Capensis* Schrad, flowers in March.

Eleocharis, R. Br.
20. *Eleocharis fistulosa* Link, flowers in October.

Cladium, R. Br.
21. *Cladium Mariscus* R. Br., flowers in January.

Ficinia, Schrad.
22. *Ficinia bracteata* Boeck.

26. RESTIONACEÆ.

Thamnochortus, Bergius.
23. *Thamnochortus* sp.

29. COMMELINACEÆ, Reichb.

Commelina, Plum.
24. *Commelina africana* L., flowers in May.
25. *Commelina benghalensis* Linn.. flowers in March.

Cyanotis, D. Don.
26. *Cyanotis nodiflora* Kunth., flowers in February.

32. LILIACEÆ, Hall.

Androcymbium, Willd.
27. *Androcymbium albanense* Schönland, flowers in July.

Polyxena, Kunth.
28. *Polyxena pygmaea* Kunth, flowers in May.

Wurmbea, Thb.
29. *Wurmbea capensis* Thunb., flowers in September.

Bulbine, L.
30. *Bulbine filifolia* Baker, flowers in January.
31. *Bulbine caulescens* L., flowers in December.
32. *Bulbine aloides* Willd, flowers in November.
33. *Bulbine narcissifolia*, Salm Dyk, flowers in March.

Anthericum, L.
34. *Anthericum Gerrardi* Baker, flowers in October.
35. *Anthericum revolutum* L., flowers in September.
36. *Anthericum falcatum* L. fil., flowers in September.

Lachenalia, Jacq.
37. *Lachenalia Algoensis* Schönland, flowers in August.

Chlorophytum, Ker, Gawl.
38. *Chlorophytum elatum* R. Br., flowers in May.

Eriospermum, Jacq.
39. *Eriospermum pubescens* Jacq., flowers in March.
40. *Eriospermum Bellendini* Sweet, flowers in March.
41. *Eriospermum Drègei* Schönland, flowers in March.

Kniphofia, Mönch.
42. *Kniphofia aloides* Mönch, flowers in April.

Aloe (Tourn), L.

43. *Aloe pluridens* Haw, flowers in May.
44. *Aloe afrikana* Mill, flowers in August.
45. *Aloe striata* Haw, flowers in June.
46. *Aloe humitis* Mill, flowers in August.
47. *Aloe ciliaris* Haw, flowers in May.
48. *Aloe micracantha* Haw, flowers in February.

Gasteria, Duval.

49. *Gasteria nitida* Haw, flowers in January.

Haworthia, Duval.

50. *Haworthia fasciata* Haw, flowers in December.
51. *Haworthia cymbiformis* Haw, flowers in March.

Veltheimia, Willd.

52. *Veldthemia viridifolia* Jacq., flowers in October.

Agapanthus, L. Herit.

53. *Agapanthus umbellatus* L. Herit, flowers in December.

Tulbaghia, L.

54. *Tulbaghia violacea* Harv., flowers in May.
55. *Tulbaghia alliacea* L., flowers in April.
56. *Tulbaghia acutiloba* Harv., flowers in December and January.

Allium, L.

57. *Allium triquetrum*, flowers in November.

Massonia, Thunb.

58. *Massonia orientalis* Baker, flowers in July.

Albuca, L.

59. *Albuca caudata*, flowers in December.
60. *Albuca Cooperi* Baker, flowers in August.

Urginea, Steinh.

61. *Urginea exuviata* Steinh, flowers in October.
62. *Urginea altissima* Baker, flowers in January.

Drimia, Jacq.

63. *Drimia haworthioides* Baker, flowers in December.

Dipcadi, Medik.

64. *Dipcadi megalanthum* Zahlbr., flowers in February.

Neodrègea, C. H. Wright, nov. gen.

65. *Neodrègea Glassii* C. H. Wright, flowers in May and June.

Scilla, L.

66. *Scilla tricolor* Baker, flowers in December.

Ornithogalum (Tourn), L.

67. *Ornithogalum thyrsoides* Jacq., flowers in November.

Asparagus (Tourn), L.

68. *Asparagus racemosus* Willd, flowers in May.
69. *Asparagus medeoloides* Thunb, flowers in August.
70. *Asparagus striatus* Thunb, flowers in May.
71. *Asparagus Krausii* Baker, flowers in October.

32a. HAEMODORACEÆ BAKER.

Wachendorfia, L.

72. *Wachendorfia paniculata* L., flowers in October.

Sanseviera, Thunb.

73. *Sanseviera thyrsiflora* Thunb.

Lanaria, Ait.

74. *Lanaria plumosa* Ait. Hort. Kew., flowers in July.

Cyanella, L.

75. *Cyanella lutea* L., flowers in November.

33. AMARYLLIDACEÆ, Lindl.

Haemanthus (Tourn), L.

76. *Haemanthus tigrinus* Jacq., flowers in May.
77. *Haemanthus albiflos* Jacq., flowers in April.

Buphane, Herb.

78. *Buphane toxicaria* Thunb., flowers in February.

Gethyllis, L.

79. *Gethyllis spiralis* L. fil, flowers in December.
 Not recorded from these parts.

Nerine, Herb.

80. *Nerine undulata* Herb. App., flowers in August.

Crinum, L.

81. *Crinum lineare* L. f., flowers in October.
82. *Crinum longifolium* Thunb, flowers in October.
83. *Crinum variabile* Herb., flowers in March.

Cyrtanthus, Ait.

84. *Cyrtanthus obliquus* Ait., flowers in December.
85. *Cyrtanthus uniflorus* Gawl., flowers in December.
86. *Cyrtanthus spiralis* Burch., flowers in February.

Agave, L.

87. *Agave americana* L.

Hypoxis, L.

88. *Hypoxis Kraussiana* Buch., flowers in December.
89. *Hypoxis aquatica* L. f., flowers in October.
 Not recorded from these parts.
90. *Hypoxis longifolia* Baker.

35. DIOSCOREACEÆ, L.

Dioscorea, L.

91. *Dioscorea elephantipes* Spreng., flowers in January.
92. *Dioscorea sylvatica* Eckl., flowers in March.
 The root of *D. sylvatica* is quite different to *D. elephantipes*.

36. IRIDACEÆ.

Moraea, Mill.

93. *Moraea polyanthos* Thunb., flowers in September.
94. *Moraea spathacea* Ker., flowers in July.
95. *Moraea setacea* Ker., flowers in August.
96. *Moraea polystachia* Ker.

97. *Moraea viscaria* Ker., flowers in November.
98. *Moraea bicolor* Spae, flowers in September.

Romulea, Maratts.

99. *Romulea parviflora* (*rosea*), flowers in September.
99a. *Romulea alba*, flowers in September.

Hexaglottis, Vent.

100. *Hexaglottis longifolia* Vent. flowers in December.

Homeria, Vent.

101. *Homeria collina* Vent., flowers in August.
Var. *Ochroleuca* Baker.

Aristea, Soland.

102. *Aristea pusilla* Ker., flowers in August.
103. *Aristea spiralis* Ker., flowers in October.

Geissorrhiza, Ker.

104. *Geissorrhiza* sp., flowers in September.
105. *Geissorrhiza bracteata* Klatt, flowers in September.
106. *Geissorrhiza secunda* Ker., flowers in February.

Fresia.

107. *Fresia refracta odorata*, flowers in September.

Hesperantha, Ker.

108. *Hesperantha falcata* Ker., flowers in September.
109. *Hesperantha angusta* Ker., flowers in August.

Bobartia.

110. *Bobartia spartacea*, flowers in July.

Tritonia, Ker.

111. *Tritonia dubia* Eckl., flowers in August.

Babiana, Ker.

112. *Babiana stricta* Ker., flowers in August, also in June.

Melasphoerula, Ker.

113. *Melasphoerula graminea* Ker., flowers in September.

Gladiolus (Tourn). L.

114. *Gladiolus recurvus* L., flowers in July.
115. *Gladiolus grandis* Thunb., flowers in September.
116. *Gladiolus var.*, flowers in May.
117. *Gladiolus undulatus* Jacq., flowers in November.
118. *Gladiolus permeabilis* Baker, flowers in November.
119. *Gladiolus gracilis* Jacq., flowers in June.

Antholyza, L.

120. *Antholyza nervosa* Thunb., flowers in February.
121. *Antholyza revoluta* Burm., flowers in June and July.
122. *Antholyza aethiopica* L., flowers in May and June.

Watsonia, Mill.

123. *Watsonia Meriana* Mill. flowers in January.

37. MUSACEÆ.

Strelitzia, Banks.

124. *Strelitzia juncea*, flowers in June and July.
125. *Strelitzia reginae*.

39. ORCHIDACEÆ, Lindl.

Holothrix L. C. Rich.

126. *Holothrix orthoceras* Reichb. f., flowers in August.
127. *Holothrix Burchelli*, flowers in October.

Habenaria, Willd.

128. *Habenaria Boltoni* Harv., flowers in October.
128a. *Habenaria arenaria*, flowers in May.

Lissochilus.

129. *Lissochilus arenarius* Lindl., flowers in November.
130. *Lissochilus Sandersoni*, flowers in January.

Satyrium, L.

131. *Satyrium coriifolium* Liv., flowers in August.
132. *Satyrium princeps* Bolus, flowers in September.
133. *Satyrium eriostemum* Lindl., flowers in October.
134. *Satyrium maculatum* Burch, flowers in November.
135. *Satyrium membranaceum*, flowers in September and November.
136. *Satyrium Hallacki*, flowers in January.
137. *Satyrium brevicornis* Lindl., flowers in November.
138. *Satyrium longicauda*.
139. *Satyrium* sp., flowers in September.

Disa, Berg.

140. *Disa cornuta*, flowers in September.
141. *Disa auriculata* Bolus, flowers in October.
142. *Disa sagittalis* Lindl., flowers in September.
143. *Disa brevicornis* Bolus, flowers in November.
144. *Disa polygonoides* Lindl., flowers in October.
145. *Disa porrecta* Swartz, flowers in March.
146. *Disa tripetaloides* N.E. Br., flowers in January.
147. *Disa lacera*, flowers in February.

Disperis, Swartz.

148. *Disperis capensis*, flowers in July.

Schizodium.

149. *Schizodium bifidum* Reich f., flowers in July and August.

Bartholina.

150. *Bartholina pectinata*, flowers in August.

Pterygodium, Swartz.

151. *Pterygodium Catholicum* Sw., flowers in September.
152. *Pterygodium carnosum*, flowers in October.

Eulophia, R. Br.

153. *Eulophia Drègeana* Lindl., flowers in May, June and July.
154. *Eulophia cochlearis* Lindl., flowers in October.
155. *Eulophia micrantha* Lindl., flowers in October.
156. *Eulophia aequalis* Lindl. Bolus, flowers in November.
157. *Eulophia tristis* Bolus et Schlechter, flowers in November.

Eulophia tristis is now *Aerolophia tristis.*
158. *Eulophia hians* Spreng., flowers in October.

Ceratandra.
159. *Ceratandra grandiflora* Lindl., flowers in November.

Angraecum, Berg.
160. *Angraecum arcuatum* Lindl., flowers in November.
161. *Angraecum pusillum* Lindl., flowers in July.

42. MYRICACEÆ, Lindl.

Myrica, L.
162. *Myrica cordifolia* L., flowers in January.
163. *Myrica quercifolia.*

RAFFLESIACEÆ.

Cytinus.
164. *Cytinus dioicus* L., flowers in September.

44. MORACEÆ.

Urostigma.
165. *Urostigma Natalense* Miq., flowers in March.

45. URTICACEÆ, Endl.

Urtica, L.
166. *Urtica urens* L.

46. PROTEACEÆ, J. St. Hill.

Protea, L.
167. *Protea latifolia,* flowers in July.
168. *Protea mellifera,* flowers in July.
169. *Protea neriifolia,* flowers in June and July.
170. *Protea cinaroides,* flowers in July.
171. *Protea Mundtii* Kl., flowers in May.
172. *Protea tenax,* flowers in June.

Leucadendron, Herm.
173. *Leucadendron adscendens* R. Br., flowers in May.
174. *Leucadendron salignum,* flowers in November.

Leucospermnm, R. Br.
175. *Leucospermum* Zeyher Meisn., flowers in October.

47. LORANTHACEÆ, D. Dau.

Loranthus, L.
176. *Loranthus oleaefolius* E. M., flowers in May.

Viscum (Tourn), L.
177. *Viscum rotundifolium* Thunb., in fruit in August.
178. *Viscum obscurum* Thunb, in fruit in June.
179. *Viscum minimum* Harv, on *Euphorbia polygona,* in fruit in June.
180. *Viscum capense* on *Rhus Krebsiana* Thunb., in fruit in June.

48. SANTALACEÆ, R. Br.

Rhoicarpus.

181. *Rhoicarpus capensis* (Wilde Granaat), in fruit in November.

Thesium.

182. *Thesium* sp., flowers in June.
183. *Thesium* sp., flowers in September.
184. *Thesium spicatum* Thunb., flowers in October.

51. POLYGONACEÆ, Lindl.

Rumex, L.

185. *Rumex sagittatus*, in fruit in March.

Emex, Neck.

186. *Emex australis* (Dubbeltje), flowers in December.

52. CHENOPODIACEAE, Less.

Exomis.

186a. *Exomis oxyriodes* Feuz., flowers in February.

Salicornia.

186b. *Salicornia fruticosa,* flowers in February.

55. PHYTOLACCACEÆ, Lindl.

Phytolacca (Tourn), L.

187. *Phytolacca stricta* Hoffm., flowers in July.

56. PORTULACACEÆ, Reichb.

Portulacaria, Jacq.

188. *Portulacaria afra* Jacq. (Spekboom), flowers in July.

Portulaca, L.

189. *Portulaca oleracea* L., flowers in February.

Anacampseros, Sims.

190. *Anacampseros filamentosa* Sims, flowers in January.

57. AIZOACEÆ, A. Br.

Aizoon, L.

191. *Aizoon glinoides* L. f. and var., flowers in December.

Tetragonia, L.

192. *Tetragonia fruticosa* L., flowers in October and November.

Mesembryanthemum, L.

193. *Mesembryanthemum salmoneum* Haw. Rev., flowers in October.
194. *Mesembryanthemum barbatum* L., flowers in September.
195. *Mesembryanthemum congestum* S. Dyk.
196. *Mesembryanthemum acinaciforme* L., flowers in September.
197. *Mesembryanthemum edule* L., flowers in August.

198. *Mesembryanthemum glomeratum* L., flowers in January.
199. *Mesembryanthemum floribundum* Haw., flowers in July and December.
200. *Mesembryanthemum turbinatum* Jacq., flowers in September.
201. *Mesembryanthemum granulicaule* Haw., flowers in October.
202. *Mesembryanthemum rigidum* Haw., flowers in February.
203. *Mesembryanthemum linguiforme* Haw., flowers in October.
204. *Mesembryanthemum echinatum* Ait. Kew, flowers in December.

58. CARYOPHYLLACEÆ, Reichb.

Spergula, L.

205. *Spergula arvenis* L., flowers in May, also September; in Europe June and July.

Pollichia, Leland.

206. *Pollichia campestris* Ait., flowers in February.

Corrigiola, L.

207. *Corrigiola littorale* L., flowers in September.

Silene, L.

208. *Silene* 3 species, 1 spec. flowers in January.
209. *Silene gallica* L., flowers in October.
210. *Silene crassifolia* L., flowers in October.

Dianthus, L.

211. *Dianthus incurvus* Thunb., flowers in November.
212. *Dianthus pectinatus*, flowers in January.

Spergularia, Prest.

213. *Spergularia media* Prest.

59. NYMPHÆACEÆ, DC.

Nymphœa (Tourn), L.

214. *Nymphœa stellata* (*Capensis*), flowers in March, also in May.

60. RANUNCULACEÆ, Juss.

Clematis, Dill.

215. *Clematis Thunbergii* Steud (Travellers Joy), flowers in May.

Ranunculus (Tourn), L.

216. *Ranunculus pinnatus* Poir, flowers in June.

Knowltania, Salisb.

217. *Knowltania rigida* Salisb., flowers in June.

61. MENISPERMACEÆ, DC.

Cyssampelos, L.

218. *Cyssampelos capensis* Thunb., flowers in April (root called Davidjes).

66. CRUCIFERÆ, B. Juss.

Heliophila, Burm., f.

219. *Heliophila* sp., flowers in August.
220. *Heliophila* sp., flowers in November.
221. *Heliophila pendula* Willd, flowers in August.
222. *Heliophila brachicarpa* Meisn., flowers in August.

Nasturtium, L.

223. *Nasturtium officinale* R. Br. Hort. Kew (Water-cress).

67. CAPPARIDACEÆ, Lindl.

Niebuhria.

224. *Niebuhria triphylla*, flowers in September.

Capparis (Tourn), L.

225. *Capparis citrifolia* Lam.

Cadaba, Forsk.

226. *Cadaba juncea* (Shepperia), flowers in May.

68. DROSERACEÆ, DC.

Drosera, L.

227. *Drosera cistiflora*, flowers in August.

69. CRASSULACEÆ, DC.

Cotyledon (Tourn), L.

228. *Cotyledon orbiculata* Linn., flowers in November.
229. *Cotyledon ramosissima* Haw., flowers in March.

Crassula, Dill.

230. *Crassula turrita* Thunb. var., flowers in November.
235. *Crassula* (*Helophytum*) *inane* E. Z., flowers in November.
232. *Crassula sphaeritis* Haw., flowers in November and January.
233. *Crassula nemorosa* E. and Z., flowers in September.
234. *Crassula lactea* Ait, flowers in May.
235. *Crassula saxifraga* Harv., flowers in May.
236. *Crassula lycopodioides* L., flowers in August.
237. *Crassula campestris* Ecklon and Zeyher.
238. *Crassula corymbulosa* Harv., flowers in March.

70. SAXIFRAGACEÆ, DC.

Montinia, L. f.

239. *Montinia acris* L. f., flowers in November.

71. PITTOSPORACEÆ, Lindl.

Pittosporum, Banks.

240. *Pittosporum viridiflorum* Sims, flowers in October.

BRUNIACEÆ, R. Br.

Berzelia.

241. *Berzelia commutata* Sond., flowers in May.

74. ROSACEÆ, B. Juss.

Cliffortia, L.

242. *Cliffortia strobolifera*, flowers in June.

75. LEGUMINOSÆ, Juss.

Cyclopia, Vent.

243. *Cyclopia Vogelii* Harv., flowers in September.

Acacia (Tourn), L.

244. *Acacia horrida* Willd, flowers in January.

Schotia, Jacq.

245. *Schotia speciosa* Jacq., flowers in October.
246. *Schotia latifolia* Jacq., flowers in May.

Cassia (Tourn), L.

247. *Cassia mimosoides* L., flowers in January.

Lotononis, E. and Z.

248. *Lotononis azurea*, flowers in November.

Aspalathus, L.

249. *Aspalathus spicata* Thunb., flowers in October and November.
250. *Aspalathus canescens* L., flowers in June.
251. *Aspalathus Adelphea* E. and Z., flowers in July.

Crotalaria, Dill.

252. *Crotalaria obscura* DC., flowers in March.

Argyrolobium, E. and Z.

253. *Argyrolobium pumilum* E. and Z., flowers in April

Trifolium (Tourn), L.

254. *Trifolium Burchellianum*, flowers in November.

Indigofera, L.

255. *Indigofera sulcata* DC., flowers in May.
256. *Indigofera heterophylla* Thunb., flowers in September.

Tephrosia, Pers.

257. *Tephrosia capensis* Pers., flowers in February.

Sutherlandia, R. Br.

258. *Sutherlandia frutescens* R. Br., flowers in September.

Hallia, Thunb.

259. *Hallia virgata* Thunb.

Vicia, L.

260. *Vicia sativa* L., flowers in December.

Rhynchosia, Lour.

261. *Rhynchosia gibba* E. Mey, flowers in September.

Dolichos, L.

262. *Dolichos gibbosus* Thunb., flowers in October.
263. *Dolichos hastaeformis* E. Mey, flowers in February.

76. GERANIACEÆ, J. St. Hil.

Geranium (Tourn), L.

264. *Geranium incanum* L., flowers in September.

Erodium, L. Herit.

265. *Erodium moschatum* Willd, flowers in November.

Monsonia, L. f.

216. *Monsonia ovata* Cav., flowers in May.

Pelargonium, L. Herit.

267. *Pelargonium heracleifolium* Jacq., flowers in November.
268. *Pelargonium longifolium* Jacq., flowers in December.
269. *Pelargonium schizopetalum* Sw., flowers in March.
270. *Pelargonium reniforme* Bot. (Rabass), flowers in April.
271. *Pelargonium grossularioides* Ait., flowers in September and November.
272. *Pelargonium urbanum* E. and Z., var. *pinnatifidum*.
273. *Pelargonium alchemilloides* Willd.
274. *Pelargonium ovale* Burm., flowers in November.

77. OXALIDACEÆ, Lindl.

Oxalis, L.

275. *Oxalis minuta* Thunb., var. *major* (*glabra*) Thunb. flowers in April.
276. *Oxalis* sp.
277. *Oxalis* sp.
278. *Oxalis cernua* Thunb., flowers in August.
279. *Oxalis corniculata* L., flowers in August.
280. *Oxalis punctata* Sond., flowers in March.

80. ZYGOPHYLLACEÆ, L.

Zygophyllum.

281. *Zygophyllum Uitenhagense* Sond., flowers in April.
282. *Zygophyllum Morgsana* L., flowers in August.

81. RUTACEÆ, Juss. (XANTHOXYLLEÆ, Nees and Mort.)

Xanthoxylon, L.

283. *Xanthoxylon Capense* Harv.

Agathosma, Willd.

284. *Agathosma Owanii* Sond., flowers in October.
285. *Agathosma commutata* Sond., flowers in September.

Coleonema, B. and W.

286. *Coleonema pulchrum* Hook, flowers in May.

Barosma, Willd.

287. *Parosma pulchella* Bth., flowers in June and July.
288. *Barosma lanceolata* Sond.

Clausena, Burm.

289. *Clausena inaequalis* (Prenzl) Oliv., flowers in August (Paardepis).

84. MELIACEÆ, Vent.

Ekebergia, Sparm.

290. *Ekebergia capensis* Sparm. in fruit in July. (Essenhout).

86. POLYGALACEÆ, Juss.

Polygala (Tourn), L.

291. *Polygala ericaefolia* Dec., flowers in September.
292. *Polygala* sp.
293. *Polygala virgata* Thunb., flowers in May.
294. *Polygala oppositifolia* L., var. *cordata*.

Muraltia, Neck.

295. *Muraltia laricifolia* E. and Z., flowers in July.

Mundtia, Kunth.

296. *Mundtia spinosa* De., flowers in June and July.

88. EUPHORBIACEÆ, J. St. Hil.

Phyllanthus, L.

297. *Phyllanthus genistoides* Sond., flowers in December.

Adenocline, Turcz.

298. *Adenocline acuta* Thunb.

Leidesia.

299. *Leidesia capensis* Mull and Arbg., flowers in August.

Ricinus (Tourn), L.

300. *Ricinus communis* L.

Cluytia, Boerk.

301. *Cluytia alaternoides* L., flowers in July.
302. *Cluytia daphnoides* Willd.
303. *Cluytia ericoides* Thunb., flowers in April.

Euphorbia, L.

304. *Euphorbia clava*, Jacq., flowers in June.
305. *Euphorbia Ledienii* Burg. flowers in August (Noors).
306. *Euphorbia ericoides* Lam., flowers in September.
307. *Euphorbia globosa* L., flowers in October.
308. *Euphorbia mammillaris*, flowers in July.
309. *Euphorbia mauritanica* L., (Melktouw).
310. *Euphorbia elliptica* Thunb., flowers in July.
311. *Euphorbia uncinata* Dec., flowers in November.
312. *Euphorbia pugniformis* Boiss, flowers in May.
313. *Euphorbia meloformis* Ait., flowers in August.
314. *Euphorbia polygona* Haw.
315. *Euphorbia viperina* Berger, flowers in October.
316. *Euphorbia erubescens* E. Mey, flowers in November.
317. *Euphorbia Peplus* Gaertn.

89. ANACARDIACEÆ, Lindl. (TEREBINTACEÆ (Juss.)

Rhus (Tourn), L.

318. *Rhus obovata* Sond., in fruit in October.
319. *Rhus glauca* Desf., flowers in May.
320. *Rhus lucida* L., flowers in July.
321. *Rhus Krebsiana*, flowers in June.

91. CELASTRACEÆ, Lindl.

Gymnosporia, Benth.

322. *Gymnosporia* sp.

Pterocelastrus, Meisn.

323. *Pterocelastrus variabilis* Sond., flowers in September, in fruit in June.

Celastrus, L.

324. *Celastrus buxifolius* L., flowers in October.

325. *Celastrus (Putterlickia) pyracanthus* Linn., flowers in October.

Cassine, L.

326. *Cassine (Maurocenia) scandens* E. and Z., flowers in November.

94. SAPINDACEÆ, Juss.

Hippobromus, E. and Z.

327. *Hippobromus alata* E. and Z., flowers in May (not Paardepis).

97. RHAMNACEÆ, Lindl.

Phylica, L.

328. *Phylica* sp. (near *villosa*), flowers in August.

328a. *Phylica axillaris* L., flowers in June.

Scutia, Commers.

329. *Scutia Commersoni* Brogn, flowers in July (Katdoorn).

98. VITACEAE, Lindl.

98. VITACEÆ, Lindl. (AMPELIDEÆ, Kunth.)

Cissus, L.

330. *Cissus cuneifolia* E. and Z., flowers in July.

99. TILIACEÆ, Juss.

Grewia, L.

331. *Grewia occidentalis* L., flowers in October (Kruisbosje).

100. MALVACEÆ, Juss.

Abutilon (Tourn), Adans.

3332. *Abutilon sonneratianum* Cav., flowers in August.

Hibiscus, L.

333. *Hibiscus aethiopicus* L., flowers in May.

334. *Hibiscus Trionum* L., flowers in March.

335. *Hibiscus pusillus* Thb., flowers in March.

Malvastrum, A. Gray.

336 *Malvastrum capense* Gray and Harv., flowers in July.

BYTTNERACEÆ, Harv.

Hermannia, L.

337. *Hermannia filifolia* L., flowers in May.

103. OCHNACEÆ, Lindl.

Ochna, L.

338. *Ochna atropurpurea* DC., flowers in August.

VIOLACEÆ, Dec.

Ionidium, Vent.

339. *Ionidium capense* R. and Sch., flowers in November and December.

114. OLINIACEÆ, C. Presl.

Olinia, Thunb.

340. *Olinia cymosa* Thb. var. *acuminata* L., flowers in September.

115. THYMELACEÆ, Reichb.

Gnidia, L.

341. *Gnidia styphilioides* Meisn.

Lasiosiphon.

342. *Lasiosiphon anthylloides*, flowers in July.

Passerina.

343. *Passerina filiformis* L., flowers in October.
344. *Passerina filiformis* var.

Struthiola, L.

345. *Struthiola parviflora*, flowers in October.
346. *Struthiola ovata*.

Arthrosolen C. A. Mey.

347. *Arthrosolen sp.*, flowers in October.

LAURINEÆ.

Cassytha.

348. *Cassytha capensis*, flowers in May.

122. ARALIACEÆ, Vent.

Cussonia, Thunb.

249. *Cassonia thyrsiflora* Th., flowers in September.

123. UMBELLIFERÆ, Juss.

Hydrocotyle (Tourn), L.

350. *Hydrocatyle hermannifolia* E. and Z.

Apium, L.

351. *Apium decumbens* E. and Z., flowers in April.

Heteromorpha, Cham and Schl.

352. *Heteromorpha arborescens* Cham and Schl., flowers in December.

Anesorhiza, Cham and Schl.

353. *Anesorhiza macrocarpa* (Anyswortel), flowers in January.

Arctopus.

354. *Arctopus echinatus* L., flowers in July.

125. ERICACEÆ, DC.

Erica (Tourn) L.

355. *Erica cerinthoides* L., flowers in April.

356. *Erica discolor* Andr., flowers in March.
357. *Erica erubescens* Andr., flowers in March.
358. *Erica decipiens* Spreng, flowers in May.
359. *Erica chloroloma* Lindl., flowers in August.

126. AQUIFOLIACEÆ.

Azima.

360. *Azima* (*Monetia*) *tetracantha,* flowers in April.

127. PRIMULACEÆ, Vent.

Samolus (Tourn) L.

361. *Samolus porosus* Thb., flowers in January.
362. *Samolus Valerandi* L., flowers in October.

Anagallis (Tourn) L.

360. *Anagallis arvensis* L., flowers in July.

128. PLUMBAGINACEÆ, Lindl.

Plumbago.

364. *Plumbago capensis* Thb., flowers in December.

Statice, Willd.

365. *Statice liniifolia* Thb. (on seashore), flowers in January.

129. SAPOTACEÆ, Dumort.

Sideroxylon (Dill) L.

366. *Sideroxylon inerme* L., (Melkhout, Stinkhout and Sneezewood).

130. EBENACEÆ, Vent.

Royena, L.

367. *Royena pallens* Thb., (Monkey apple).

131. OLEACEÆ, Lindl.

Olea (Tourn), L.

368. *Olea exasperata* Jacq.
369. *Olea verrucosa* Link, flowers in October.

Jasminum (Tourn), L.

370. *Jasminum angulare* Vahl, flowers in Jaunary.

133. GENTIANEÆ, Dumort.

Sabeae, Soland.

371. *Sebaea aurea* R. Br., flowers in November.

Chironia, L.

372. *Chironia peduncularis* Lindl., flowers in June.
373. *Chironia baccifera* L., in fruit in May.

Limnanthemum S. G. Gmel.

374. *Limnanthemum Thunbergianum* Griesb., flowers in February.

134. APOCYNACEAE, Lindl.

Carissa, L.

375. *Carissa Arduina* Lam, with red fruit, flowers in August.

376. *Carissa Arduina* Lam var., with black fruit.

Pachypodium, Lindl.

377. *Pachypodium bispinosum* DC, flowers in October.

135. ASCLEPIADACEÆ, Lindl.

Secamone, N. Br.

378. *Secamone Thunbergii*, flowers in October.

Sarcostemma R. Br.

379. *Sarcostemma viminale* R. Br., flowers in March.

Schizoglossum, E. Mey.

380. *Schizoglossum* sp.

381. *Schizoglossum linifolium* Schlechter, flowers in March.

382. *Schizoglossum cordifolium* E. Mey, flowers in August.

Cynanchum, L.

383. *Cynanchum crassifolium* E. Mey, flowers in October and February.

384. *Cynanchum sarcostemmatoides* K. Schum, flowers in June.

385. *Cynanchum capense* Thunb., flowers in October.

Gomphocarpus R. Br.

386. *Gomphocarpus grandiflorus* Decne, flowers in January and June.

387. *Gomphocarpus mucronatus*, flowers in February.

388. *Gomphocarpus crispus* R. Br., flowers in May.

Fockea, Enoll.

389. *Fockea glabra* Decne., flowers in July.

Microloma, R. Br.

390. *Microloma linearis* O. Kze, flowers in April.

Ceropegia, L.

391. *Ceropegia stapeliaeformis* Harv., flowers in December.

392. *Ceropegia carnosa* E Meyer, flowers in February.

Huernia, R. Br.

393. *Huernia Thureti* Cels., flowers in April.

Stapelia, L.

394. *Stapelia verrucosa* Jacq., flowers in April.

136. CONVOLVULACEÆ, Vent.

Falkia, L.

395. *Falkia repens* L., flowers in October.

Dichondra.

396. *Dichondra repens* Forsk, flowers in August.

Convolvulus (Tourn), L.

397. *Convulvulus mulitifidus* Thb., flowers in November.

Ipomea L.

398. *Ipomea biloba*, Forsk, flowers in March. Sand Dunes near the sea.

137. BORAGINACEÆ, Lindl.

Ehretia, L.

399. *Ehretia hottentotica* Burch, flowers in October.

Lobostemon, Lehm.

400. *Lobostemum* sp., flowers in September.

Echium, L.

401. *Echium violaceum* L., flowers in October.

Echinospermum Sw.

402. *Echinospermum* Lappula Lehm., flowers in September.

139. LABIATAE, B. Juss.

Salvia (Tourn), L.

403. *Salvia aurea* L., flowers in October.
404. *Salvia uncinata* L., flowers in November.

Stachys (Tourn), L.

405. *Stachys æthiopica* L., flowers in April.

Leonotis, R. Br.

406. *Leonotis Leonotis* R. Br. (Klip Dagga), flowers in July.
407. *Leonotis leonurus* R. Br., flowers in May.

Teucrium, L.

408. *Teucrium africanum* Thb., flowers in March.

140. SOLANACEÆ, Hall.

Lycium, L.

409. *Lycium horridum* Thb., flowers in July.
410. *Lycium tenue* Willd., flowers in May.

Physalis, L.

411. *Physalis mimima* L., flowers in February.
412. *Physalis peruviana L.* (Cape Gooseberry), flowers in May and June.

Solanum (Tourn), L.

413. *Solanum quadrangulare* Thb., flowers in April.
414. *Solanum nigrum* L.
415. *Solanum sodomeum* Duval, flowers in June.

Datura, L.

416 *Datura stramonium,* L.

Nicotiana.

417. *Nicotiana glauca* R. Graham, flowers in January.

SELAGINEÆ, Rolfe.

Selago L.

418. *Selago rotundifolia* Thb., flowers in May.
419. *Selago decumbens* Thb., flowers in September.
420. *Selago corymbosa* L., flowers in January.
421. *Selago* sp., flowers in January.

Walafrida, E. Mey.

422. *Walafrida nitida* E. Mey, flowers in September.

Hebenstreitia, L.

423. *Hebenstreitia dentata* L., flowers in October.

141. SCROPHULARIACEÆ, Lindl.

Hyobanche, L.
424. *Hyobanche sanguinea* L., flowers in September.

Nemesia, Vent.
425. *Nemesia* sp.
426. *Nemesia strumosa* Benth, flowers in July.
427. *Nemesia floribunda* Lehm.
428. *Nemesia barbata* Bth.

Halleria, L.
429. *Halleria lucida* L. (white Olive wood), flowers in July.

Lyperia.
430. *Lyperia foliolosa* Krauss. (*Sutera* Hiern), flowers in September.

Manulea, L.
431. *Manulea obovata* Benth, flowers in June.

Chaenostoma, Benth.
432. *Chaenostoma campanulata* Drège (*Sutera campanulata* O. Kuntze), flowers in April.

Phyllopodium, Benth.
433. *Phyllopodium cuneifolium* Bth., flowers in April.

Zaluzianskya, F. W. Schmidt.
434. *Zaluzianskya* (*Nycterinia*) *capensis* Walp., flowers in May.

Veronica (Tourn), L.
435. *Veronica Anagallis* L.

Melasma, Berg.
436. *Melasma capense* Hiern., flowers in November.

Hemimeris, L.
437. *Hemimeris montana* Sf., flowers in September.

Harveya, Hook.
438. *Harveya* sp., flowers in October.
439. *Harveya purpurea* Harv., flowers in October.
440. *Harveya hyobanchoides* Schlechter, flowers in August.

Limosella L.
441. *Limosella Capensis* Thunb., flowers in October.

142. BIGNONIACEÆ, Pers.

Tecomaria, Spach.
442. *Tecomaria* (*Tecoma*) *capensis* Spach, flowers in April.

146. LENTIBULARIACEÆ, Stapf.

Utricularia, L.
443. *Utricularia* sp., flowers in December.

147. ACANTHACEÆ, Juss.

Thunbergia, L.f.
444. *Thunbergia capensis*, var. flowers in April.

Chaetacanthus, Nees.
445. *Chaetacanthus glandulosus* Nees, flowers in December.

Barleria, L.
446. *Barleria pungens*, flowers in December.

Blepharis, Juss.
447. *Blepharis procumbens* Pers., flowers in July.
448. *Blepharis hirtinervia* T. Anders, flowers in July.
449. *Blepharis mollugínifolia* Pers., flowers in February.

Justitia (Houst) Linn.
450. *Justitia capensis* Thb., flowers in June.
451. *Justitia pulegoides* E. Mey, flowers in February.

148. PLANTAGINACEÆ, Lindl.

Plantago (Tourn), L.
452. *Plantago hirsuta* Thb., flowers in November.

149. RUBIACEÆ, B. Juss.

Pavetta, L.
453. *Pavetta caffra* L.f., flowers in December.

Anthospermum, L.
454. *Anthospermum ciliare* L., flowers in June.

151. DIPSACACEÆ, Lindl.

Scabiosa (Tourn), L.
455. *Scabiosa columbaria* L., flowers in November.

152. CUCURBITACEÆ, Hall.

Zehneria Endl.
456. *Zehneria scabra* Sond., flowers in May.
457. *Zehneria hederacea*, flowers in August.

153. CAMPANULACEÆ, Juss.

Wahlenbergia, Schrad.
458. *Wahlenbergia undulata* A. De., flowers in November.

Lightfootia, L. Herit.
459. *Lightfootia rubens*, Buch., flowers in January.
460. *Lightfootia albens* Spreng, flowers in March.

Cyphia, Berg.
461. *Cyphia linarioides* Presl., flowers in April.
462. *Cyphia* sp.

Lobelia, Plum.
463. *Lobelia coronopifolia* L., flowers in December.
464. *Lobelia erinus L. var.: bellidifolia*, flowers in September.
465. *Lobelia scabra (Dobrowskya) scabra* Thb.
466. *Lobelia (Grammatotheca* Presl) *erinoides*.

Laurentia Mich.
467. *Laurentia radicans* Schönland sp. var., flowers in June.

154. COMPOSITAE, Vaill.

Vernonia, Schreb.

468. *Vernonia corymbosa* Less, flowers in May.

Conyza Less.

469. *Conyza ivaefolia* Less. flowers in June.

Erigeron, L.

470. *Erigeron canadense* L., flowers in July.

Felicia, Cass.

471. *Felicia echinata* DC., flowers in April.

Nidorella, Cass.

472. *Nidorella resedaefolia* DC. var,, flowers in April.

Chrysocoma, L.

473. *Chrysocoma tenuifolia* Bg., flowers in September.

Tarchonanthus, L.

474. *Tarchonanthus camphoratus* L., flowers in May.

Helichrysum, Vaill.

475. *Helichrysum fœtidum* Cass., flowers in April.
476. *Helichrysum felinum* Less.
477. *Helichrysum Xeranthemoides* DC., flowers in May.
478. *Helichrysum squamosum* Thunb., flowers in January.
479. *Helichrysum undatum* Less, flowers in August.
480. *Helichrysum anomalum* Less. flowers in August.
481. *Helichrysum striatum* Th., flowers in October.
482. *Helichrysum erosum* Harv., flowers in March.

Xanthium (Tourn), L.

483. *Xanthium spinosum* L. (Burrweed), flowers from July to September.

Arctotis, L.

484. *Arctotis stœchadifolia* Berg., flowers in July.

Osteospermum L.

485. *Osteospermum grandidentatum* DC., flowers in April and October.
486. *Osteospermum monoliferum* L., flowers in July.

Pteronia L.

487. *Pteronia incana* Less. flowers in October.
488. *Pteronia elongata* Thb., flowers in December.

Chrysanthemum (Tourn) L.

489. *Chrysanthemum Coronarium* L.. flowers in November.

Senecio, L.

490. *Senecio multibracteatus* Hv., flowers in July.
491. *Senecio angulatus* L., flowers in October.
492. *Senecio juniperinus* L., flowers in October.
493. *Senecio deltoides* Less. flowers in July.
494. *Senecio glutinosus* Thb., flowers in September.
495. *Senecio paucifolius* DC.. flowers in May.
496. *Senecio othanœflorus* DC., flowers in May.
Senecio erubescens Ait., flowers in June.

Euryops, Cass.

497. *Euryops algoensis* DC.

Dimorphotheca, Vail.

498. *Dimorphotheca fruticosa* Less. flowers in September.
499. *Dimorphotheca Ecklonis* DC., flowers in October.

Ursinia, Gaertn.

500. *Ursinia annua* Less, flowers in July.
501. *Ursinia chrysanthemoides* (*Gaertn.*) now *Sphenogyne* R. Br., flowers in July.

Gerbera, Gron.

502. *Gerbera cordata* Less. flowers in May.

Gazania, Gaertn.

503. *Gazania uniflora* Ker., flowers in April.
504. *Gazania pinnata* Less. flowers in April and October.

Berkheya, Ehrh.

505. *Berkheya lanceolata* Willd., flowers in July.

Taraxacum, Wiggers.

506. *Taraxacum officinale* Weber. flowers from May to October.

Lactuca (Tourn) L.

507. *Lactuca capensis* Th., flowers in February.

Stobaea, Thb.

508. *Stobaea atractyloides* Th., flowers in March.
509. *Stobaea scolymoides* DC., flowers in May.

Metalasia, R. Br.

510. *Metalasia aurea* Don Wern. Trans., flowers in June.

Helipterum Dec.

511. *Helipterum phlomoides* DC., flowers in June.

Cryptostemma, R. Br.

512. *Cryptostemma calendulaceum* R. Br., flowers in May.

Cenia, Comm.

513. *Cenia turbinata* Pers., flowers in May.
514. *Cenia sericea* DC.

Cotula, Gaertn.

515. *Cotula ceniæfolia* DC. var., flowers in November.

Corymbium, L.

516. *Corymbium nervosum* Th., flowers in December and January.

Diplopappus, Dc.

517. *Diplopappus asper* Less (Aster), flowers in May.

Disparago, Gaertn.

518. *Disparago ericoides* Gtn., flowers in July.

Eriocephalus, L.

519. *Eriocephalus umbellulatus* DC., flowers in June.

Kleinia, L.

520. *Kleinia articulata* Haw, flowers in April.
521. *Kleinia radicans* DC. (Bockkost), flowers in April.
522. *Kleinia ficoides* Haw. flowers in June.

Arctotis, L.

523. *Arctotis stæchadifolia* Berg., flowers in July.

Printzia, Cass.

524. *Printzia Bergii*, Cass., flowers in August.

SOCIAL LIFE IN A SOUTH AFRICAN TRIBE.—The tribe referred to is the Thonga nation, a group of Bantu clans whose habitat comprises portions of Natal, Transvaal, Rhodesia and Portuguese East Africa, extending along a littoral from the vicinity of St. Lucia Bay to the Sabie River mouth near 21° south latitude. The social customs and other interesting details regarding this tribe are described by the Rev. H. A. Junod in the first volume of his work, which has recently issued from the press.* In a preliminary chapter the author considers the Thonga tribe geographically and historically. He estimates its numbers at 750,000. Excellent though the Thonga memory may be, the tribal traditions down to the beginning of last century are so characterised by legendary traits that all events of earlier date must be regarded as belonging to the tribe's prehistoric period. The main body of the volume is divided into three parts. In one of these the career of the individual Thonga is followed from birth to death, first in the case of a typical man, and then of a typical woman belonging to the tribe, including specially all customs and ceremonies pertaining to such important events as birth, marriage, the incidence of old age, death and burial, after which comes the rites associated with the great mournings and the destruction of the deceased's hut. In the second part of the volume Mr. Junod proceeds from the unit to review the social organism, and treats of Thonga family and village life. The kinship system is a marvel of complication: it extends far beyond the simple relationships of grandparents, uncles, aunts and cousins, which form the limits for most civilised folk, and enters into many minutiæ of detail. These refinements bring in their train taboos upon marriage within certain degrees of consanguinity, and so marriage is permissible only to parties outside the eighth degree of relationship. While dealing with this part of his subject, Mr. Junod strongly animadverts on the practices of polygamy and lobola (or wife purchase), and calls on the South African Governments to aid the missionaries in the repression of these evils. The closing section of the book is devoted to the national life of the tribe. The villages make up the clan, the clans together make the tribe, and particularly is the tribal authority of Chief, with Court, and Army, here discussed. Of the ethnographical worth of Mr. Junod's compilation there can be but one opinion, and great service has been rendered to science in securing such a record ere the opportunity slips away. That it will soon thus pass the author warns us as an ethnographer, even while, as a missionary, he feels impelled to indicate the line along which the Thonga race must be guided in order to escape shame and degradation.

* *Vide* this volume, p. 118, *ante*.

THE SALT PANS OF THE COAST REGION.

By William Godly Stockdale Stead.

The subject of this paper is one which I have been keenly interested in for many years, but, unfortunately, constant search for scientific information regarding salt and salt-pans and their formation in South Africa has failed to supply me with any paper of importance upon this subject.

There are many salt-pans in South Africa that are being worked in a most primitive manner, and consequently produce nothing but rubbish. Possibly the owners labour under the same difficulties that I had to contend with for many years, and are not inclined, nor have the time, to carry out experiments whereby they might overcome the many obstacles that beset them and hinder them from producing a better and more satisfactory article.

Every assistance is given by the Government through its scientific men to those who cultivate the land and raise the stock, but nothing appears to have been done to assist those who possess these valuable assets—salt-pans.

We still go on from year to year importing large quantities of salt, which should not be. There are sufficient pans in South Africa to produce all the salt that is required, but unfortunately the quality produced does not come up to a satisfactory standard; this is solely through lack of proper scientific knowledge of how to produce the best.

We have in our vicinity several salt-pans. (1) The Zwartkops, known as the Grootpan, in the district of Uitenhage, on the north of the Zwartkops River. (2) The Bethelsdorp pan, near the village of Bethelsdorp, where the London Missionary Society established their station, and whence Dr. Livingstone commenced his great trek into greater Africa. (3) The North End salt-pan, now known as the Lake, having been abandoned as a salt producer and converted into a pleasure lake. (4) The Korsten pan: this pan is very small, surrounded by clay deposit, and indifferently worked by a few natives.

What may be considered the Premier Pan is the Zwartkops, on an estate connected with the main line of railway by a branch-line *via* Aloes. Although work was commenced many years after salt had been discovered at the Bethelsdorp pan, the output has reached as high as 60,000 bags (6,000 tons) in a single season. The finest quality salt of great saline strength and uniform grade that has ever been produced by solar evaporation in Africa was produced at this pan from the commencement of operations.

I will deal further with this pan after giving a brief history of the Bethelsdorp pan, as far as I have been able to gather from the older inhabitants of the village.

Some time early in the eighteenth century the London Missionary Society wandered inland in search of a suitable locality to establish their mission station. They struck what they considered a large lake of fresh water more or less filled with vegetation. Abundance of fresh water for their own use and for their stock induced them to settle in the spot now known as Bethelsdorp.

The Mission records shew that Port Elizabeth was at one time described as "a fishing village" near Bethelsdorp, and as old pictures of Bethelsdorp shew "three-storied buildings," church, etc., it must have been a village of no mean size. Whether these records are correct, or merely flights of imagination, I cannot say, but it does seem singular that the Bethelsdorp salt-pan is not mentioned in Cape history until many years later, whereas mention is made of trek parties obtaining supplies of salt, "after crossing the Zwartkops River," from an inland Lake.

It was not long before some disturbance took place in the Lake. The nature of the disturbance I have not been able to discover, but the probable explanation is that wells were dug either for irrigation purposes, or to obtain fresh spring water. This disturbance must have opened up the lower strata in the lake, and caused the strong brine that was flowing underground to rise to the surface. This would naturally very soon kill all vegetation either in or around the lake, and commence to deposit salt in the shallows. This speedily opened up the first salt industry of the Cape. That it was considered an industry and an asset to the village there can be no doubt, for when the missioners moved northward, or abandoned the station, they left to the natives each a garden plot and a village plot, and in the title-deeds to the present day it particularly states that each erfholder is entitled to an allotted space in the salt-pan for the purpose of gathering salt for his own benefit, subject to payment of threepence per three bushels' royalty: this is collected by a board of supervisors and goes toward the upkeep of the school and village funds.

The process of making and gathering salt is conducted upon very primitive methods, and after many years of working no serious attempt seems to have been made, or scientific knowledge made definite use of to improve the conditions that exist.

Salt-pans are about one to two square miles in surface area; some pans are what we would call open workings, salt being gathered on the edge of the water as it recedes toward the centre. Other pans have a portion boarded off into sections, each section being anything from 50 square yards to 20,000 square yards; this boarding prevents mud from being washed into the working area by flood water. As the summer months advance and the atmospheric temperature increases to, say, 85° Fahr., the brine reaches a density of about 28° Twaddle (S.G. 1.140) evaporation goes on rapidly. Although salt has been forming previously, as the density of the brine increases the whole process becomes visible to the observer, and it is extremely interesting to watch. Flat flakes may be seen forming on the surface of the brine; they gradually increase to the size of a threepenny bit; as this increases in weight the slightest disturbance precipitates it to the bottom, where salt crystals are formed. This goes on until a floor of salt is formed under the brine.

Salt forming and precipitation goes on quickest in three to four inches: the water then reaches a greater degree of warmth than it would at a depth of, say, seven or eight inches. In an atmosphere of about 100° Fahr. to 114°, which it sometimes is, evaporation is so rapid that artificial concentration of the brine is unnecessary, as the density increases to 44° Twaddle (S.G. 1.220). This precipitation of salt flakes forms on the floor of clay crystals of salt to a thickness of half an inch to three inches. This is what is called the *Blad* (leaf). When this *blad* is three-quarters to one inch thick it is considered sufficiently strong to bear the weight of a man without cracking; any cracks would allow the mud and sand to come through and discolour the salt while making.

The *blad* or leaf that has formed is on the surface covered with sharp pointed salt crystals and somewhat painful for unaccustomed feet to walk upon. When the *blad* is sufficiently hard men are sent in the pan with spades or blind rakes, with straight iron edges, and with these they work off the crystals until the *blad* is smooth. The backward and forward movement with pressure on the spades sets up an agitation, and in addition to the crystals scraped off the *blad* further salt is precipitated. The crystals that are scraped off the *blad* are of various sizes, from coarse to fine.

When the worker has scraped together sufficient salt he commences to wash it in the surface brine; this frees the salt from dirt and sand and leaves it of a beautiful bluish white colour. The salt is then placed on the bank of the pan and the mother liquid or bittern allowed to drain off. It is then carted to the stores for drying and, when necessary, grading purposes.

The Zwartkops pan when not visited by exceptionally rainy seasons shews exceedingly good results when one considers that the actual working days in a season rarely exceed fifty-two to sixty. Their production is anything from 20,000 to 40,000 bags (each bag weighing 200 lbs.) per season. The season commences about the end of November and ends early in April. A glance at the rain-fall table for this district for these months shews that 52 days is all the time during which it is possible to work; after a fall of about two inches of rain work is stopped for some days. It is not possible to work the whole of the pan area, so if we take an average yield of 30 lbs. per square yard of workable area we are very near the mark.

The Zwartkops pan is about 30 feet and the Bethelsdorp about six feet above sea level. The salt from the first-named is of an opaque crystal, and that from the latter pan of a chalky white crystal; the two salts can always be distinguished apart.

The same primitive methods of producing salt are in vogue as some thirty years ago. For the last five years the yield at the Zwartkops pan has not been as good as during the previous years, whether through the unfavourable seasons or a falling off of the brine supply I am unable to say.

To many people it appears strange that the process of salt making is carried on under about three inches of water. In many pans the salt leaf is allowed to become absolutely free from surface brine before the salt is gathered, but this could only be classed as "picked up" salt; it is of the coarsest and dirtiest grade.

Having given briefly the process of making and gathering salt, I will give a few particulars of what has come to my notice during the time I have had salt pans under my observation. Salt pans are not as some people imagine small basins in some out-of-the-way-spot, but large lakes from one to two square miles in extent. They are often supposed to be inland lakes of sea water that have been left far behind by the receding waters of the ocean, this sea water during the course of years having evaporated and deposited salt crystals, which in turn have impregnated clay, sand and mud, and that now it requires only a rainfall on these lakes for this water in time to become brine, in turn re-evaporating and depositing its product on the surface of sand and mud, or that by capillary attraction the brine from these underground crystals is brought to the surface.

Another belief is, that just as the salt water of the ocean became salt by the rivers that flowed into it, gathering the salts of the earth, so inland lakes, too, become salt-pans. If this theory were correct, the clay, sand, or mud, would soon become exhausted of its saline substances and the constant withdrawal of salt from the surface of the lake would cause organic growth again to become predominant. Instead of which the more a salt-pan is worked, and the workable area kept free from sand or mud the greater is the output of salt.

During the summer months the unworked surface area of the pan becomes encrusted with salt from the brine that is not used for salt beds, so that after a rainfall this surface salt is dissolved and thus increases the density of the brine. The driving backward and forward of the surface water by prevailing winds materially assists the salt worker, who opens the sluice gates and allows the brine to flow into the working area by its own gravitation. If this brine flow is insufficient, he resorts to pumps and makes use of the wells. Well-brine makes better and purer salt, as it contains less impurities. At the same time the worker prefers the surface brine, as it is much warmer and does not dissolve the *blad* when allowed to flow thereon. Well-brine is cold and has to be let into warming beds before it is allowed to flow on to the spruits. The surface brine sometimes reaches a density of 45° Twaddle (1.225). The conclusion that I have come to regarding the origin of these salt-pans rests on the following facts:—

(1) The lake was previously a fresh water lake, until brine was brought to the surface by a disturbance.

(2) Certain areas boarded in to keep out mud soon became filled with organic growth of a red or darkish colour, and unless brine be pumped thereon such areas soon became useless.

(3) The impregnated mud, clay, or sand or the capillary attraction should in theory keep rain water sufficiently supplied with brine to make salt.

(4) Wells at a depth of 15 to 20 feet give good supplies of brine, and at a distance of six miles from the pan two test drillings have, at 40 to 80 feet, shewn strong streams of brine to be flowing underground. Neither these wells nor the underground streams are affected by the ocean tides.

(5) The strata of salt-pans usually consist of mud, clay, red marl, sandstone and of a black shale.

(6) In the Free State and northern Cape Colony it is necessary to cut through the black shale or rock before brine is tapped, and without digging wells and pumping brine few pans could produce salt.

When visiting a salt-pan either near the coast or up-country one is sure to observe in parts of the pan, at certain times of the year, a red colouring. This red colour is erroneously thought by the natives and many others to be due to an excess of saltpetre in the brine. For some time I was inclined to believe this, owing to the blinding sharpness of the brine after heavy working or extreme heat. I have been able closely to observe this reddish appearance, and am now convinced that it is an organic growth, caused in the first instance by an excess of fresh water in certain parts of the pan, and when the brine becomes stronger this red growth becomes more confined and prominent. Stagnant streams or ponds also shew this growth.

In salt-pans near the coast small shrimp-like creatures that live and thrive in the strongest brine (both surface and well) may be observed. This "shrimp," I believe, feeds on the red growth and assists in preventing it from becoming a menace to the industry. In up-country pans, where I have found that the "shrimp" does not exist, the red organic matter is a pest. Crystals of Calcite (or Aragonite) are found deposited in the sand and clay of the salt-pans at the coast and also in the salt-pans of the Orange Free State. Black shale is found in the vicinity of the pans at a depth of about 20 feet. This shale is probably what was found by the Missioners many years ago and was thought to be coal. I have a letter, dated 1834, reporting the discovery. It was most sanguinely expected that good coal would be found by penetrating deeper into the ground, and that, in view of the coming Steam Navigation, Bethelsdorp would be rich indeed.

The comparative yield of the pans inland as against those near the coast is very interesting. For instance, as previously stated, the yield at Zwartkops does not exceed half a bushel (30 lbs.) per square yard of worked area, while the yield of the pans in the Free State is 12 bushels per square yard per season. This is accounted for by the fact that inland (say 400 miles) they are favoured with 250 working days in a year, a dry climate, and a rarefied atmosphere.

I would strongly advise a visit to the salt-pans first in winter and then again in summer. In the winter one sees the lake full of water, of a slightly briny taste. In the summer the water is of a stronger brine, given a few days warm dry weather, when the surface water evaporates and leaves a sheet of salt covering the whole pan.

Cluytia Similis.—At a recent meeting of the Chemical Society (London) Tutin and Clewer communicated the results of a chemical investigation of *Cluytia similis* Muell. Arg. procured from East London. The shrub has a reputed value as an antidote for anthrax and also for snake-bite poisoning. Smith, in his "South African Materia Medica"* refers to what is apparently this species of *Cluytia*. The plant was found to be devoid of alkaloid in every part, but in its above-ground portions a small amount of an essential oil was found, possessing a strong rank odour. In addition to chrysophanol, fumaric acid, and apparently a trace of salicylic acid, a new acid was isolated, possessing the composition $C_{10}H_{10}O_4$. A new ester was also extracted from the plant, having the formula $C_{49}H_{98}O_2$, for which the name Cluytyl cluytinate is proposed, as it is formed by the combination of two new compounds, cluytyl alcohol ($C_{28}H_{57}OH$) and Cluytinic acid ($C_{20}H_{11}CO_2H$). A new phytosterol, which it is proposed to designate Cluytiasterol was separated in large colourless leaflets, and gave the formula $C_{27}H_{43}OH$. There was also isolated a new tetrahydric alcohol, proposed to be called cluytianol; its composition is $C_{29}H_{46}O(OH)_4$. A fuller description of the new compounds isolated during the course of the investigation will be found in the *Journal of the Chemical Society*, vol. 101, pp. 2221-2234. The investigation was performed in the Wellcome Chemical Research Laboratories.

TRANSACTIONS OF SOCIETIES.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, October 19th: Mr. H. A. White, Vice-President, in the chair.—"Farming with dynamite": W. **Cullen.** The application of explosives to farming operations was generally discussed, and the explosives best adapted for subsoiling, stump blasting and other agricultural operations were considered, as well as the special tools and appliances required for such purposes.

South African Institute of Electrical Engineers.—Thursday, June 20th: J. H. Rider, V.P.I.E.E., President, in the chair.—"A few examples of electrically-operated mechanical appliances": H. **Collens.** The author

* 1895 edition, pp. 56 and 57.

described in detail an electrically-operated dual control passenger lift and a free barrel crane clutch, also referring, more briefly, to the automatically-operated telephone exchange.

Thursday, September 19th: J. H. Rider, V.P.I.E.E., President, in the chair.—"Some practical aspects of electric winding": S. E. T. **Ewing.** Electric winders from deep shafts were discussed in regard to their working costs, and the two classes of safety devices used in connection with them, namely, those providing against the failure of the power supply, and those rendering harmless mistakes on the part of drivers.—"Practical operations of the three-phase hoists at the Bantjes Consolidated Mines, Limited": J. **Askew.** All the winding on this property is being performed by three-phase induction motor hoists; these were shortly described and records given of the work actually being done by them.

Thursday, November 21st: Mr. J. W. Kirkland in the chair.—"Notes on some modern electrical machinery": F. H. **Michell.** The author's notes dealt with several electrical factories and works recently visited by him in England and Germany.—"Power as a bye-product": J. W. **Kirkland.** Conditions existing in connection with an important mine in Rhodesia were described, in which considerable amounts of power were obtainable without any fuel expenses. In one case the power is furnished by the water supplied to the mine in its descent from a ridge 740 feet higher than the storage tanks at the mine. Another case of bye-product power is due to the location of the mine at a considerably higher level than the reduction works, so that the ore has to be lowered down an incline.

Rhodesia Scientific Association.—Friday, 22nd November: Mr. H. W. Garbutt, Vice-President, in the chair.—"Natives of the Zambesi Valley—North Side": C. F. **Macnamara.** The author stated that the natives inhabiting the valley on the north side were divided into six different tribes, namely, Batonga, Bawi, Barumbera, Banamainga, Babgoba, and Makorikori. The Barumbera were of a miserable and weedy type, the others of rather fine physique. Proceeding, he dealt with the language, tribal peculiarities, laws and customs, native law and agriculture.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, November 16th: W. R. Dowling, M.I.M.M., President, in the chair.—"The action of alkalies on phenolphthalein": D. I. **James.** Experiments were detailed, from which the author concluded (1) that, using an excess of alkali, the colour intensity is directly proportional to the amount of alkaline phenolphthalein present, and (2) maintaining the amount of phenolphthalein constant, but varying the proportions of alkali, the maximum colour is obtained by using two molecules of alkali to one of phenolphthalein, after which further additions of alkali do not increase the colour. The results of investigations into the rate of destruction of the colour by excess of alkali were also communicated.

South African Institution of Engineers.—Saturday, December 14th: Mr. J. A. Yule, President, in the chair.—"Notes on the commercial aspect of municipal electricity supply undertakings": H. J. **Holder.** Reference was made to the need of cheap production and disposal of electrical energy, and of devising a tariff suited to the social requirements of the public and capable of giving the best price to the best consumer. The best methods of giving publicity to the advantages offered by such undertakings were also discussed.

STOMATA AND DROUGHT RESISTANCE IN MEALIES.

By Horace Athelstan Wager, A.R.C.S.

This investigation was undertaken on the suggestion of Mr. J. Burtt-Davy, Government Botanist of the Transvaal, to whom I am indebted for placing material at my disposai. The object of the investigation was to obtain an insight into the relationship, if any existed, between the number of stomata preesnt in the leaves and the power for drought resistance. It was also to find out if those species adapted for drought resistance had assumed any xerophytic characters such as reduction of stomata, thickening of cuticle, covering of hairs, etc. The following notes with the appended table are the results obtained in those species examined. The cuticle in those cases not specially mentioned was about 5 microns thick on both surfaces.

Silver King. Midrib strong; upper surface with few short scattered white hairs; under surface and edge smooth. Cuticle about 8 microns thick on both surfaces.

North American. Midrib strong; upper surface slightly hairy, with short white hairs; under surface glabrous; edge ciliate.

Iowa Silver Mine. Midrib not very strong; few very short hairs on upper surface, under surface and edge smooth.

Boone County. Midrib very strong; upper surface with minute scattered hairs; under surface and edge smooth.

Improved Leaming. Midrib strong; upper surface with few scattered white hairs, under surface and edge smooth. Cuticle hardly developed, but slightly thicker on upper surface.

Potchefstroom Pearl. Midrib fairly strong; upper surface rough with many small hairs; under surface and edge smooth. Cuticle, upper surface 8 microns, under surface 7 microns.

Hickory King. Midrib not strong; upper surface with very few scattered short hairs; under surface and edge smooth. Cuticle, upper surface 3 microns, under surface 4 microns.

Hildreth Yellow Dent. Midrib strong; both surfaces and edge smooth. Cuticle, both surfaces 3 microns.

Farmers' Reliance. Midrib fairly strong; both surfaces and edge smooth.

North Dakota Golden. Midrib very strong; upper surface with sparsely scattered long white hairs; under surface and edge smooth.

Bloody Butcher. Midrib strong; both surfaces and edge smooth.

Queen of the Prairies. Midrib very strong; upper surface with few fine white hairs; under surface and edge smooth. Cuticle, upper surface 5 microns, under surface 7 microns.

Southern Horsetooth. Midrib fairly strong; both surface and edge smooth.

Champion White Pearl. Midrib fairly strong; upper surface few long white hairs; under surface glabrous; edge slightly ciliate.

Johnson County. Midrib very strong; both surfaces and edge smooth. Cuticle, both surfaces 4 microns.

Cock's Prolific. Midrib not strong; upper surface sparsely hairy; under surface and edge smooth.

German Yellow. Midrib fairly strong; upper surface slightly hairy; under surface and edge smooth.

Mealie.	Stomata per sq. mm.		Length of Stomata in microns.		Resistance to drought.
	Upper.	Lower.	Upper.	Lower	
Silver King	81	106	49	48	fair
North American ...	98	95	50	50	very good
Iowa Silver Mine ...	95	107	60	50	very good
Boone County ...	65	87	60	50	very poor
Improved Leaming ...	60	69	50	50	fair
Potchefstroom Pearl ...	69	83	50	50	good
Hickory King ...	74	74	48	52	very poor
Hildreth Yellow Dent	68	106	51	45	good
Farmers' Reliance ...	68	85	47	49	good
North Dakota Golden	67	80	49	46	poor
Bloody Butcher ...	83	74	45	48	good
Queen of the Prairies	67	96	48	43	fair
Southern Horsetooth...	66	65	52	51	fair
Champion White Pearl	74	86	45	45	fair
Johnson County ...	74	80	48	43	very good
Cock's Prolific ...	82	85	48	43	good
German Yellow ...	80	102	48	44	very good

The stomata were measured from the end limits of the guard cells. By examining the table it will be seen that the number of stomata in nearly all cases is greater on the under than on the upper side. It is rather surprising to find so many stomata in comparison on the upper side, as the leaves usually are far from being vertically placed. The size of the stomata also appears to be related to the number, the larger stomata being found with the lesser number, that is, on the upper surface. The drought-resisting capacity does not seem to bear any relation to the number of stomata. In fact, no drought-resistant characters appear to be present such as special thickening of cuticle, sinking of stomata, etc. My opinion now is that the capability for drought resistance has to do with the presence of a peculiar structure on the epidermis of the leaves in the form of small special groups of absorbing and storing cells, which I think are found in varying numbers according to the species.

As, however, the present paper deals only with the consideration of the stomata, I have left the investigation of these absorbing cells for another later occasion.

ELECTRICAL ILLUMINATION.—Of Messrs. C. Griffin & Co.'s series of scientific and technical works, probably those dealing with chemical and metallurgical subjects are the best known in South Africa. Prof. H. Bohle, of the South African College, has recently, and by no means for the first time, contributed to that excellent series a book dealing with electro-technics. Its title is "Electro-photometry and Illumination,"* and it is primarily intended as a text-book for second-year engineering students. It contains, in an amplified form, the lectures delivered by the author during 1911. A great many of the tests described were carried out in the laboratory of the South African College, and in this book they appear for the first time. Although the book is intended primarily for college students, others interested in illuminating engineering, such as medical men, architects, teachers, and even the general public, will find it useful. The first three chapters are mainly occupied with photometry; the principles on which photometric measurements depend are explained and the most important light-standards described. Then radiation and its effects claim attention, special reference being made to the physiological action of the ultra-violet rays, as well as to their germicidal properties, and, in this connection, to their commercial application for purifying water. Full description is given of various kinds of photometric apparatus and of the appliances needed for the equipment of a photometer room. After a chapter devoted to light flux and distribution, the author passes on to deal with electric lamp testing, incidentally discussing the question whether our lamps are run with the most economical efficiency, showing how this may be determined, and under what circumstances commercially better results may be obtained. A good deal of consideration is given to the designing of reflectors and shades, and the remark is made that opal and frosted globes absorb a considerable amount of light, and that prismatic, or "holophane" shades and reflectors produce better results. The closing chapter of the book deals with illuminating engineering. The illuminating engineer has to satisfy two requirements simultaneously: those of physics and of physiology. He should therefore be careful not to neglect one at the expense of the other. Here colour and uniformity of illumination are of great importance. Suggestions are made for the lighting of private houses and different classes of public and semi-public places, and several illustrative examples of illuminating engineering are given, including the library and assembly room of the Hiddingh Hall, South African College. A lengthy bibliography of chief publications subsequent to 1906 is appended to the book.

* Large 8vo. pp. xii, 222. 10s, 6d, nett.

LACCOLITES AND BYSMALITES.

By Prof. Ernest H. L. Schwarz, A.R.C.S., F.G.S.

The term laccolite was first used by W. K. Gilbert in 1879, in his Report on the Geology of the Henry Mountains, Utah. A laccolite is a mass of intruded rock which has come into its position in a molten state through supply dykes which communicate with the lower portions of the earth's crust. When the idea was first promulgated dykes were supposed to have wedged themthemselves along fissures which opened for the admission of the molten rock and, then, if a suitable horizontal plane of parting presented itself, the molten rock would follow along this line of weakness and produce a "sill." New rock thrust in between bedding planes or other horizontal planes in sedimentary rocks necessitates the uplifting of the overlying strata. A laccolite is a local bulging of a sill, and the uplifting was originally supposed to have been concentrated in one particular spot and a local uplift to have occurred. It is very plain that the original Henry Mountain laccolites have domed up the superincumbent strata, though these amounted in thickness from 7,000 to 11,000 feet, according to Gilbert. The mode of intrusion was that a vertical fissure opened and molten rock came up it, driven by hydrostatic pressure from below; at a certain horizon the more or less vertical fissure stopped, and the magma continuing to be pumped up, drove upwards the beds above where the vertical fissure came to an end, and such was the force impelling the molten rock that two miles of cover were readily bent upwards. In the case of a sill such as we have examples of in the Karroo, a small supply dyke communicates with the main mass, which is often hundreds of square miles in area and three to four hundred feet thick. The lowest sills in the Beaufort West district are under a cover of not more than 2,000 feet of sediment; but the sills are arranged one above the other, and the topmost sill must have been under considerable cover, otherwise the molten rock would have burst through to the surface and have formed volcanoes. A conservative estimate, therefore, of the cover lifted by the lowermost sills in Beaufort West, supposing the uplift theory is correct,—which I doubt,—would be 5,000 feet. Some of the sills are more than 2,000 square miles in area, and over this whole area the overlying sediments are supposed, on the uplift theory, to have been raised three or four hundred feet. There may have been many supply dykes instead of one, but even in that case the mechanical difficulties of transmitting such a huge uplifting force from the supply dykes to the further corners of the sills, would seem to disprove the theory. The crust of the earth is supposed to be fissuring to allow the entrance of the molten magma, and at the same time it is supposed to allow the transference of a gigantic force by hydrostatic pressure. It would be the same as trying to force water up an ordinary jointed pipe from sea-level to the top of Mount Blanc, the pressure of some 16,000 feet being about the same as that of the cover of rock, of specific gravity 2.7, which the molten rock was supposed to have driven upwards.

In South Africa the case is quite clear. The Karroo dolerites have not lifted their cover, but have melted and absorbed the rocks along planes of easy solution. At the same time, the evidence in South Africa must not be taken to disprove the unlift theory in other countries where the conditions are different. As a rule dykes, sills and laccolites are frequent in shale formations and are very sparingly found in sandstones. This, to a certain extent, if not exclusively, is due to the fact that rocks with several diverse constituents are more readily melted, or dissolved, than ones with only one predominant mineral, as in sandstones, the other constituents forming fluxes, which lower the melting point. In South African rocks, dykes in Table Mountain sandstone, Kheis quartzites and Black Reef quartzites are exceedingly rare, whereas in the shaly Pretoria series and Karroo beds they are very common. In limestones they are moderately frequent, but of small dimensions. Under favourable conditions, where dolerite, for instance, invades a sandstone formation, then the uplift would tend to develop. For some such reason the laccolites on the western edge of the North American prairies have developed, and strings of them have probably been responsible for the mountains of "block uplift," the Wahsatch, Sevier and other plateaux of Utah and Colorado. Even in the American laccolites, types occur which have partially dissolved out their cavities,such as in Cross' compound laccolite of El Late Mountains in Colorado. In others, as in the Judith Mountains in Montana and Mount Hillers in the Henry Mountains, subsidiary sheets have been sprung in between the sediments which have been uplifted like in the *lit-par-lit* injection round granite massives; in these cases the sheets are of considerable dimensions and often break across the strata, enclosing slabs of rock, which then become Xenoliths, and which may become absorbed in the magma. In this way a process of stoping down the roof may considerably enlarge the cavity. No such perfect fusion of the sedimentary rocks which once occupied the space where the laccolites now lie is found in America as in South Africa. Nevertheless, the gradation from the one form to the other shows that there is no essential difference in their nature; hence it is perfectly justifiable to use the term for our enlarged sills occupying cavities which they have melted out for themselves as it is for the American type, which have forced the cavity open by hyydrostatic pressure.

Evidence that dykes absorb the rocks into which they are thrust is everywhere available in the Karroo. On the bare slopes of the Nieuweveld in Beaufort West the great dykes and sills of dolerite are seen traversing the sedimentary rocks with no disturbance whatever of the planes of bedding. Fissures do occur as in the one filled in with coal at Leeuw Rivers Poort, west of

Beaufort West; here the crack comes up vertically for a distance, then follows the bedding planes horizontally, and finally strikes upwards and pinches out. Such a cavity possibly started before the dolerite came up, but whereas a narrow fissure of this kind, a few feet wide, produces no perceptible alteration in the beds, when it becomes enlarged to a hundred or more feet wide to accommodate one of the great dykes, there would have resulted a considerable disturbance if the dyke merely pushed aside the country rock. The dykes come up with remarkably parallel sides, and pass off into sheets, sometimes even stopping dead at a particular horizon with a square termination. Only once has a dyke been seen coming up along the plane of a small fault, but this was in Matatiele, where the sandstones play a far more important part than in the Karroo proper. The best evidence, however, is afforded by the laccolites of the Transkei, where the sedimentary rocks are seen abutting directly against the sides of the laccolites as if they had been shorn off. In the Quizzyhota laccolite along the Kei River, near the railway bridge, the vertical side of the laccolite facing the river is 1,500 feet high, and the shales of the Karroo system lie quite unaltered up the vertical face; a certain amount of thermal alteration has gone on in the immediate neighbourhood of the dolerite, but there is no disturbance of the stratification. In this particular laccolite the mass of igneous rock has an elevated ridge running parallel to the river front, and a short way from the vertical face the main mass of the laccolite runs into the hills with horizontal upper surface some 80 feet below the elevated crest. The strata lying upon this lower portion are horizontal, and in one of the kloofs there is a sheer cliff exhibiting a section of where these strata abut upon the rising dome of the elevated crest, and one can see perfectly plainly that the ends of the strata abut on the face of the dolerite as if they had been cut away to receive it.

If it is possible, then, that the dolerite melts out the cavity which it subsequently occupies, what becomes of the surplus material? It is out of the question to suppose that the sedimentary rocks should spontaneously melt and change to igneous rock, for the dolerite, which is the commonest dyke rock in South Africa, is invariably more basic than the shales into which it is intruded.

Compare an average shale and an average dolerite:—

	Slate.	Dolerite.
Silica	54 per cent.	50 per cent.
Alumina	13	14
Iron oxides	9	17
Lime	7	10
Magnesia	6	6
Potash	1	1
Soda	2	2
Carbon dioxide	4	
Water	4	

The only substance which is notably in greater quantities in the dolerite is the iron, and this correspondence of the chemical composition of shales with dolerite, to my mind, explains the predilection of dolerite for intruding itself into shales. But in any body of shales, unless one is dealing with the vast palaeozoic slate formations of Europe, there are always sandy beds, in which the percentage of silica rises to 80 or 90 %, and generally one may state that the average composition of a varied slate and sandstone formation, such as the Beaufort beds, for instance, contains nearer 70 % silica than 50 %. When dolerite, therefore, invades an area of slate it finds a rock not very different in composition to itself, and a small amount of original liquid material, by incorporating the country rock, may spread out and occupy a very considerable space. Nevertheless, some new material must be brought in, and consequently some of the substance of the absorbed slates must be passed away. From the figures given above, this will be principally silica, and its only channel of escape is the supply dyke. A rising column of liquid igneous rock must, therefore, function as efferent as well as an afferent mass, that is to say, the acid waste products of the absorption of the sediments must diffuse downwards through the up-welling basic magma.

In the deeper portions of the crust the principal massifs of igneous rock are granite. If we admit the downward passage of acid material, some reservoirs in the deeper portions of the crust ought to be found filled with igneous rock of acid composition; some of the granite massifs, therefore, should be of such an origin.

In the south-west of Cape Province the overlying Karroo sediments have been removed by denudation, and also, to a certain extent, the Cape Formation. The latter is predominantly an arenaceous formation, and hence should not contain much injected igneous rocks; but the shales below the Table Mountain sandstone are very freely injected with granite, and the massifs are exposed in Table Mountain, Paarl, Malmesbury, Robertson, George and elsewhere. Those which owe their origin to the absorption of strata and reception from above of the residual acid material from the basic intrusions I propose to call bysmalites. The term bysmalite was proposed by Iddings in 1898 for intrusions of magma which had been forced vertically through other rocks and solidified in the form of plugs. They are laccolites exaggerated in the vertical dimension and, according to Iddings, accompanied by vertical faulting of the containing rocks. The type is taken from Mount Holmes in the Yellowstone Park. The only reason that Iddings adduces for the faulting is that the beds abut abruptly on the igneous rock, and, denying that the igneous rocks can have melted out their cavity, the only alternative is to bring in faults to explain the phenomenon. In the basic intrusions, however, we can everywhere see in South Africa that absorption has taken place; therefore, a granite massif with steep sides and the strata abutting against it would be a bysmalite.

The bysmalite that I think most nearly approaches the idea of a receptacle for the waste products from above is the granite boss at Robertson. The strata intruded are steeply-folded Malmesbury beds, clay slates, mica-schists, limestones and carbonaceous shales. The sediments show a concentric arrangement round the granite, and, to a certain extent, lateral thrust has taken place; but when a plug of a mile in width by two miles in length is intruded into sediments there is hardly room to doubt that the whole space now occupied by the granite has not been created by thrusting aside the walls of a cavity. The argument becomes still more pertinent with regard to the granite underlying the Cape Peninsula and the mass surrounding Saldanha Bay, which, are many miles across in either direction. In the Robertson granite, in addition, there is evidence of extensive *lit-par-lit* injection on the southern side. The granite substance has been thrust in between the laminae of the slates in such a way that it is impossible to tell where the granite ends and the sediments begin. One can trace the gradual absorption of the slates by the igneous magma. At Sea Point the absorption was of a different nature, due no doubt to the tougher nature of the clay slates, which are not easily split for the injection of thin veins of granite-substance. The dykes that come off the granite penetrate the slates in numberless stout projections and frequently enclose slabs of the slates in the granite. On the road above many "basic segregations" on the granite were exposed in the cutting, and these may be regarded as the slabs of slate almost entirely absorbed.

If one takes a mica-schist as the normal rock intruded by granite, that is, a slate which has been altered by the abstraction of the more soluble substances—iron, lime, etc.—and compares it with a normal granite, we have the following figures:—

	Mica-schist	*Granite.*
Silica	67 per cent.	77 per cent.
Alumina	19 „ „	13 „ „
Iron oxides	4 „ „	2 „ „
Magnesia..	2 „ „	—
Lime..	—	—
Soda	2 per cent.	3 per cent.
Potash	4 „ „	5 „ „

The features of the absorption of the mica-schist by the granite will, therefore, be that more silica is called for, alumina is in excess, iron is to be got rid of, and soda and potash are wanted. If we suppose there is an interchange of substances going on between the basic magma on top with the acid magma below through the channels of connecting dykes, then the silica required will come down and satisfy the magma, the alumina is sufficient above and the granite substance cannot absorb it; therefore it has to be got rid of somehow, and the very general development of silicate of alumina crystals in the form of andalusite, chiastolite and sillimanite in the rocks around the granite accounts for this. The soda and potash can be derived from the overlying basic magma, for though the generalised analysis given above shows the soda and potash in equilibrium in the slate and the dolerite, nevertheless the carbon-dioxide and water in the slate, if abstracted, as they do not enter into the interchange of substances, would render the available percentage of soda and potash in the slate somewhat in excess of that required by the dolerite. The figures quoted are intentionally round numbers, but they express what is meant; anyone who objects to the theory could adduce analyses which would disprove the whole argument, but the analyses selected are general averages. What is contended, however, is that, in South Africa at least, injection of basic rocks implies the simultaneous injection of acid rocks deeper down, and that the spaces occupied by basic and acid rocks are far in excess of what could have been created by simple thrusting aside of the sediments, and hence absorption of the sediments has taken place in both cases.

In the question of the supply dykes which connect the acid and basic intrusions, these are frequently seen traversing the granite, fine examples being shown in the Lion's Head and Wynberg, in the Cape Peninsula. These, however, are simple dolerite dykes. There should be somewhere, if the theory outlined above is a true explanation, dykes of intermediate composition, that is to say, sometimes consolidation should have taken place before the acid and basic constituents had had time to separate out. In the great laccolite regions of the Kei and Kentani and in Cradock these intermediate dykes are quite frequent. In the neighbourhood of the great Quizzyhota laccolite, which is only one of many gigantic lumps of dolerite in the neighbouring divisions, there are two great parallel dykes of diorite which, from their easy weathering, have given rise to a double furrow across the country from the sea-level at the Komgha River to Cathcart, known as the Transkei Gap.

The Diffusion Dumb-bell.

Taking the whole evidence which the granite bosses, the dolerite dykes and the dolerite laccolites afford us in Cape Province, one is led to conceive of a system of igneous injections of a dumb-bell shape. Below we have the Malmesbury clay-slates, above the Karroo sediments, in between the various silicious sediments of the Cape system, or sometimes, in the north, of the Pal-Afric group, Kheis quartzites and Pretoria iron-bearing quartzites. Below, the magma eats out great holes and fills them with granite; above the same magma eats out the holes and fills them with basic rock. In between are thin dykes of communication, usually dolerite, but under certain conditions diorite. The slates above and below became absorbed, and the material from both was added to the general stock of magma. The average magma remained fluid in this dumb-bell system for some time, till, for some reason, the acid part concentrated in the lower part and the basic in the upper part, the diffusion taking place through the narrow part of the dumb-bell, and sometimes the average magma became caught in this part and consolidated as diorite.

The facts are plain enough, and it is perhaps as well to content oneself with them at present; but there is an explanation which, if only speculative, may be worth mentioning in order to show that this differentiation of an average magma is not wholly unexpected.

The Ionic Separation of Substances on a Rock-magma.

When an iron-bearing rock weathers at the surface of the earth, the iron does not travel outwards to the sea along with the soda, lime and potash, but seeks the centre of the earth.* The fact is easily recognisable in the replacements of limestone by iron ores, which is of common occurrence; in these cases certain conditions have caused precipitation of the iron from solution, but where the conditions are not favourable, then the iron goes on its journey downwards towards the base of the crust. Weak solutions such as those which carry the iron are ionised, and the metallic ion carries a positive charge of electricity; the metallic ion possibly is attracted by the magnetic core of the earth, but however that may be, the iron goes down and must come to rest in the base of the crust, beyond which water cannot penetrate. This would lead to an accumulation of a positive charge at the base of the crust. Above this is suspended a solution or a fluid magma which is an electrolyte,† that is, one in which the substances are ionised, and the metallic ions carry a positive charge and the acid ions a negative one. Under such circumstances, the negative ions would be attracted by the positive charge at the base of the crust; and the metallic positive ions would be repelled, and in that way a magma of everage composition would be diffferentiated into an acid and basic series, the acid part accumulating in the lower half of the dumb-bell and the basic in the upper. Whether this cause is sufficient for the effect I do not know, but, considering the immense time during which geological phenomena take place, a small but persistent electrical attraction and repulsion such as exists under the circumstances would have far-reaching effects; one is astonished, rather, at the smallness of the differentiation; one would expect a complete separation into ultra-acid and ultra basic magmas.

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* E. H. L. Schwarz: "Causal Geology," 1910, p. 73; "Selective absorption of substances in the earth's crust," Report S.A. Assoc. for Advancement of Science, 1913, p. 181.

† C. Barus and J. P. Iddings, *Amer. Journ. Sci.*, vol. xliv, 1892, p. 242.

POISONOUS PROPERTIES OF *MESEMBRIANTHEMUM MAHONI*, N.E.BR.

By JOSEPH BURTT-DAVY, F.L.S., F.R.G.S.

In December, 1909, specimens of *Mesembrianthemum Mahoni* N.E.Br., were received from Mr. P. B. Carlisle, of Hopefield, P.O. Lawley Station, Witwatersrand, with the following information:—

The plant is chiefly found growing on kopjes. Certain Natives make a preparation from the root, which they use as a fermenting agent for the manufacture of the drink popularly known as "khadi," and as the rising principle for bread. The bark is scraped from the root, and the residue dried and powdered. It is said, however, that the root contains some poisonous principle that in time proves injurious to the khadi-drinker. "I should like, therefore, to know if this latter is so, and if so, to what extent it would be dangerous to use the powdered preparation as a ferment, either for liquids or for bread."

In a further communication Mr. Carlisle stated that the Natives to whom the locality of the root is known are very jealous of the secret; they fear that if Europeans get to know of it the plants will be destroyed in the interests of temperance. Khadi, he added, is only used, he believes, by certain tribes, and it is only to them that the plant is known; he had personally searched unsuccessfully for it. There seems to be no doubt as to the poisonous nature of the root, unprepared. It is said to produce a "bloated" sensation.

In January, 1910, Mr. Carlisle described the method of preparation of the powder for bread-making, as follows:—

Scrape the bark off the root; leave the root to dry (this takes two to three days in dry weather, or about five in wet); powder with a mortar as finely as possible; soak for one day in water; draw off the water, and dry, or if it is needed in haste, it can be used damp.

It is then used as follows: Mix a teaspoonful of powder with a teaspoonful of sugar; add about a wineglass of lukewarm water; in about a minute the mixture will begin to effervesce; when this occurs add a saucerful of flour and enough lukewarm water to make a thick batter. Keep this in a warm place till it is "working" well (about two hours or longer); then take flour (any amount up to, say, 20 lbs.); put the sponge in the flour, and mix salt and lukewarm water as usual; mould into loaves, and set to rise (about three hours). Bake as usual. The rising-time may be much longer if convenient. "This bread does not go sour."

I arranged with Mr. Carlisle for the supply of 25 lbs. weight of the dried roots. This material was forwarded to the Director of the Imperial Institute in June, 1910, with a request that the poisonous properties be investigated. A report was received, under cover of a letter dated December, 1911, which stated that the roots contain a quantity of oxalates equivalent to about 3 per cent. of oxalic acid, and that there is little doubt that the poisonous effects produced by the roots are due to these constituents.

The following is an extract from the report of the Imperial Institute:—

The sample weighed about 7 lbs., and consisted of small twisted pieces of the roots, which were covered with knotted rootlets. The roots were light-brown externally, but white internally, and were hollow and shrivelled.

A microscopical examination of the material showed that parts of the root were covered with a fungus, to the activity of which their fermenting power was due.

On chemical examination the roots were found to contain a quantity of oxalates, equivalent to about 3 per cent. of oxalic acid.

Oxalic acid and its salts are poisonous, and the injurious effects resulting from the habitual use of beverages prepared by the acid of this root are no doubt due to the oxalates present.

In view of these results it is not desirable that the roots of *Mesembrianthemum Mahoni* should be used as a substitute foı yeast in making bread. Their activity in inducing fermentation seems to vary considerably in different specimens, so that it may be necessary occasionally to use an unduly large proportion of the powdered root in bread-making, and in these circumstances poisoning might ensue.

Since the above report was received, the writer has found that the roots of another species of *Mesembrianthemum* (Burtt-Davy, No. 12,265) are also used as a substitute for yeast in the Cape Province. This species grows in the Karoo, near East-poort, Bedford Division, where it is known as T'Kerriemoru; the root is peeled, dried and powdered, and mixed with prickly pear juice or honey, and when fermented the material is used to make bread rise. In the absence of flowering specimens, I have not yet been able to determine the species.*

Andrew Smith states that a species of *Mesembrianthemum* ("probably *M. bellidiflorum*") is used by the Hottentots to soften skins for clothing. "They make a paste of the plant, and work in the juice into the skin with a stone."

In a valuable paper on "Kaffir-beers, their Nature and Composition,"† to which my attention has only just been called, Dr. Juritz notes the following plants also used in the preparation of Kaffir-beers:—

Lineum capense Thunb.;
Mesembrianthemum stellatum Mill.;
Anacampseros ustulata E. Mey.

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* The plants have since flowered, and have been determined by Mrs. F. Bolus as *M. stellatum* Mill.

† *Agricultural Journal* (Cape), vol. XXVIII., 1906 No. 1, pp. 35-47.

To these three the vernacular names, "Moer" and "Moola," or "Mula" (i.e., *yeast*), are applied, while the Mesembrianthemum is also called "Koerri"- or "Kiri"-moer. Dr. Juritz concludes:—

"The term "mula" or "moola" is without doubt a corruption of the Dutch "moer" (signifying yeast); the r of the Dutch word being convertible into l in Kaffir (cfr. sugar = swekile, and koerri or kiri = qilika: hence also Kiri moer = moola ye qilika). In default of the mould, the root alone is powerless to start fermentation. The means for transporting the ferment is clearly the sediment invariably found wherever a sugary or starchy liquid ferments; in this case the root materials amongst which organisms of various kinds lie entangled."

The flora of certain Kaffir-beers has been studied by Miss E. M. Doidge,* who finds that in the beers, "leting" and "joala" or "utshawala," the fermentation is due to three organisms: (1) A lactic acid bacterium belonging to the group *Bacterium Guntheri*, Leh. and Neu., and resembling in its action the *Bacillus bulgaricus* described by Metchnikoff, and to the results of which action the beneficial effects of "leting" are due; (2) *Mucor Rouxii*, the mucor of Chinese yeast; (3) A yeast which is responsible for the formation of the greater part of the alcohol.

A New Cape Buchu.—It is recorded in the *Kew Bulletin* that specimens of a buchu from the grassy slopes at the Qolora Mouth, Kentani, Cape Province, prove to belong to a species previously undescribed. They had been sent to Kew by Miss Alice Pegler, and the species has accordingly been named *Barosma Peglerœ* Dummer. The new species exhibits an affinity to forms of *Barosma lanceolata* Sonder, but has broader elliptic leaves. It is a perennial, and develops annual leafy and flowering shoots from a woody root-stock. Whether the leaves of the newly described species possess any particular pharmaceutical value still remains to be ascertained.

Proto-hydrogen.—In 1896 Prof. Pickering, of Harvard, discovered in the spectrum of the star ζ Puppis a system of lines not previously recognised, and at first believed to belong to a new element. These lines were afterwards attributed to a new form of hydrogen existing at an exceptionally high temperature, to which Sir Norman Lockyer gave the name of protohydrogen. Hitherto these lines have not been found in terrestrial hydrogen, but Mr. A. Fowler announced at a recent meeting of the Royal Astronomical Society that he had produced some lines of the series by passing a condensed discharge through a mixture of hydrogen and helium. From hydrogen alone he failed to obtain them.

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* The Flora of Certain Kaffir Beers; Transvaal Department of Agriculture, *Agricultural Science Bulletin* No. 5, 1910.

METHODS OF SERO-DIAGNOSIS APPLICABLE TO DISEASES OF STOCK IN SOUTH AFRICA.

By D. Kehoe, M.R.C.V.S.

It has been thought necessary by the writer, in dealing with this subject briefly to outline some of our conceptions as to the manner in which the animal organism reacts to the introduction of certain material either constituting or derived from other organisms.

These materials include cells, either animal or vegetable in nature (bacteria), toxic products, ordinarily non-toxic albuminous substances, and ferments, and from our present point of view we can apply to these bodies the collective term of Antigens, since they are capable on introduction into the animal body, under certain conditions, of giving rise to certain bodies, which are most commonly termed Antibodies. The use of the expression " antibodies " is now very widespread (although the term "Reagins" has also been suggested), and we may distinguish between the normal antibodies which may be found in the animal in a state of nature and the acquired antibodies found in the animal under either experimental or pathological conditions. This division into normal and acquired antibodies is made for the sake of convenience only, and does not imply that there is any difference between an antibody formed under natural conditions and an antibody with identical action which is found under the conditions of experiment or disease, the difference apparently being only quantitative. This naturally follows, since we can only form ideas of their nature from their actions, with their antigens or each other, as we are ignorant of the real nature of these bodies. Their actions and inter-actions are explained by some workers according to chemical theories, whilst others are inclined to regard these actions as being capable of explanation according to physical or, rather, physico-chemical laws, arguing from the analogy between the behaviour of the united antibody and antigen and that of colloid substances in solution when influenced by the addition to that solution of either other colloids or crystalloids.

The various antibodies which we shall briefly review are the Antitoxins, Antiferments, Lysins, Agglutinins, Precipitins and Opsonins, and these we shall deal with in this order, indicating later how they can be made use of in sero-diagnosis.

Antitoxins.—Between the years 1888 and 1890 the discovery was made by Roux and Yersin in the case of Diphtheria and Faber, Brieger and Fraenkel, and Kitasato in the case of Tetanus, that the organisms causing these diseases could, when grown in suitable liquid media, form in the liquid certain products which, on injection into the body of a susceptible animal, were capable of producing symptoms similar to those caused by the living bacilli causing these diseases. To the soluble germ-free products obtained by filtration of the liquid cultures of these organisms the term Toxin was applied, and this term has since come to be applied to the poisonous bodies in general, by which the pathogenic bacteria are believed to produce their harmful effects. It is not the case that all of the pathogenic bacteria form large quantities of toxic products, which can be obtained by filtering the liquid media in which they have been grown; in fact, this property is limited to a small group, the best-known members of which are the *B. diphtheriæ*, *B. tetani*, and the *B. botulinus*. The toxins thus formed by these organisms are distinguished as extra-cellular or exo-toxins from the endocellular or endotoxins, by which the other pathogenic bacteria are believed to produce their effects. It is thought that these endotoxins (which have been demonstrated to be incorporated in the bacterial protoplasm, by experiments, where in some instances the killed bacteria and in other cases an extract of the ground-up or dissolved bacterial bodies have been injected into animals) are either excreted into the body fluids of the animal where the organisms are present, or more probably only escape subsequent to the death and solution of the bacterial cell.

Very little is known of the true nature of toxins, owing to the difficulty of isolating them in a pure state, and it has not yet been definitely ascertained whether they are excreted from bacteria as such, or whether they are produced as the result of some bacterial product acting on some of the constituents of the medium in which the bacteria are present.

However, shortly after the discovery of diphtheria and tetanus toxins it naturally occurred that a close study of their actions on the animal body was made, the earliest workers in this line being Behring, Kitasato and Wernicke in 1890. These workers found that when the toxins of the causal agents of these diseases were injected, under suitable conditions as to dosage and channel of introduction, into the bodies of susceptible animals, the blood-serum of these animals acquired, after a time, certain properties in virtue of which it was able to exercise a neutralising effect on the particular toxin used for the injection of the animal from which the serum was subsequently obtained, and that the neutralising property of the serum was specific in its action. It was further found that not alone did the animal thus treated acquire an active relative immunity to the particular toxin used, but also that its serum was capable of conferring a passive relative immunity against the specific toxin used when injected into another susceptible animal, if the conditions of dosage were properly adjusted.

To the protective substances in the serum of the " prepared " animal there came to be applied the term Antitoxin, owing to the direct neutralizing effect which was seen when these substances acted on the toxin. Later on Ehrlich was able to demonstrate the formation of antitoxin in response to the administration of the toxic products derived from the plants *Ricinus communis*, *Abrus precatorius* and *Robinia pseudacacia*.

the poisonous principles being Ricin, Abrin and Robin respectively; and following this, in 1894, Calmette produced similar effects by the injection of certain snake-venins. In a similar way antiferments have also been produced by injecting animals with various ferments, such as Emulsine, Rennin, Pepsin and many others. Other antitoxic sera have been produced since then.

At the present time it is not definitely known how the direct neutralizing effect, which is seen on injecting the toxic body and its respective antibody, either separately and at about the same time or after they have been mixed together, is brought about. Ehrlich believes that the union of toxin and antitoxin is of a chemical nature, whilst Bordet and others suggested that it could be regarded as an adsorption phenomenon occurring between two colloid substances.

The facts in favour of these theories will not be reviewed here, but the outcome of researches made in attempting to settle this question, was to furnish us with a method for the standardization of the powers of antitoxins, also the formation of theories regarding the nature of the re-action of the animal body to the action of toxins, and the further extension of these theories to include reactions to antigens of other natures.

The method adopted for the standardization of the antitoxins of Diphtheria and Tetanus in general use at the present time is to estimate, in the first instance, the smallest quantity of the toxin necessary to kill a guinea-pig, weighing 250 grammes, in from four to five days, this dose being known as the " minimum lethal dose " of the toxin. The quantity of antitoxic serum which, when mixed with 100 such minimal lethal doses of toxin, is sufficient to neutralize the toxin and prevent the death of the guinea-pig within the given time is spoken of as the " immunity unit " or " antitoxin unit," and when one knows what this quantity is, it is easy to calculate how many immunity units are present in one cubic centimetre of a given serum.

In standardizing antitoxins it will be seen from the above that one must possess either a standard toxin or antitoxin, and it is the latter which is used. It is prepared in a dry form by dessication over anhydrous phosphoric acid *in vacuo,* in a dark cool place, and issued from certain well-known laboratories. Using a solution of this powder, the neutralizing value of a given toxin can be ascertained against it, and the neutralizing effect of the antitoxin whose power is to be determined is then estimated against this same toxin, and thus the antagonizing powers of the standard antitoxin and that under examination can be compared.

The study of the toxin-antitoxin reaction led Ehrlich to believe that toxin really contained other bodies, to which he gave the names toxons and toxoids, all possessing varying affinities for antitoxin, and also led him to formulate his famous " side chain theory " of immunity, which though not accepted by all workers in immunity, nevertheless acts as a working hypothesis in regard to serum-immunity, and by furnishing ideas which remain to be proved or disproved by other workers acts also as a stimulus for further research in what appears at present to be an almost unlimited field. Briefly, his theory is as follows:—Arguing from the structure of certain organic compounds which are composed of a central stable chain or group of atoms with side chains or groups which are concerned in entering into reaction with atoms or groups of atoms of other elements or compounds, he concluded that the animal cell was composed of a central group of molecules, which are combined in the manner most suitable for the performance of the specific functions of that cell, and which entered into relations with assimilable material by means of certain subsidiary side-chains of atomic groupings, or, as he preferred to call these latter, receptors. These receptors he regarded as being concerned normally in the performance of the physiological nutrition of the cell, the molecules of the food supplied by the body juices coming into relation with the protoplasm of the cell through their agency. Now, the toxin molecule he regarded as being possessed of two portions, one a binding or haptophore portion, by which, he believed, the toxin, when introduced into an animal's system, became bound to the receptors of the cell on which the toxin acted, the poisoning effect being brought about by the other group, which he termed toxophore. If, however, the cell responded by casting off the injured receptor or receptors before the central mass of protoplasm had become irreparably damaged, then he thought that, in conformance with the biological law enunciated by Weigert, viz., the repair of the cell being always in excess of the damage caused to it, it would form a number of receptors in excess of those injured by the toxin, and these being cast off from the cell, and in solution in the body fluids, would constitute the antitoxin, since they would bind the toxin molecules by uniting with their haptophore groups, and thus prevent them entering into further combinations with the receptors attached to the body cells. This, then, is the side-chain theory of immunity in regard to the formation of antitoxins, and we shall see as we proceed how it was expanded in order to fit in with the facts disclosed by later experiments.

Lysins.—For a long time it was known that bactericidal and hæmolytic properties were present in the blood of normal animals. It was in 1888 that Nuttall described the bactericidal effect of normal serum on certain organisms, and, later, Buchner showed that heating the serum to 55° C destroyed this lytic property. Even as far back as the period between 1869 and 1875, the existence of the normal hæmolysins had been noted by Creite and Landois in connection with the transfusion into animals of blood of those of other species not closely related. Such transfusions were noted to lead to the production of hæmoglobinuria, due to solution of the red corpuscles, both, it was believed, of those of the treated animal and of those of the blood introduced into its body. Our later and extended knowledge of these subjects may be said, however, to date from the discoveries by Pfeiffer and Bordet in connection with bacteriolysis and hæmolysis.

It was in 1894 that Pfeiffer found that, on introducing large numbers of living cholera vibrios into the peritoneal cavity of guinea-pigs actively immunized against these organisms, the vibrios underwent a granular degeneration, succeeded eventually by solution of their bodies. Further, he noted that the same effect on the vibrios could be produced in normal guinea-pigs by introducing into their peritoneal cavity, at the same time as the organisms, a small quantity of peritoneal exudate or serum from an actively-immunized animal. This constitutes the well-known "Pfeiffer's phenomenon." Then Metchnikoff showed that this bacteriolysis occurred not alone *in vivo*, but also *in vitro*, on the addition of a mixture of normal peritoneal fluid and serum from an animal immunized against cholera, to a suspension of cholera vibrios in a test tube. Then Bordet, having demonstrated the fact that fresh, normal serum could replace the normal peritoneal fluid of the guinea-pig, proved further that if the serum from the cholera-immune animal was fresh, and not heated to 60° C, as it had been in Metchnikoff's experiments, that, by itself, when added to a suspension of cholera vibrios, it could produce their lysis. Then, going further, he showed that this serum from the cholera-immune guinea-pigs, though producing bacteriolysis when fresh, lost this power, or became inactivated, on heating to 55° C, but the lytic power could be restored to the heated serum, or, in other words, it could be reactivated, by the addition to it of fresh normal serum. Thus, he directly conceived the idea that there were two bodies, whose presence was necessary for the production of bacteriolysis, one a thermolabile body, destroyed by heating the serum to 55° C, and the other a thermostable one, which resisted the effect of heating even to 70° C for one hour To the first he gave the name alexin, and to the second the name of substance sensibilisatrice.

Now, as the bacteriolytic property of the serum from the cholera-immune guinea-pig was specific, only acting on the cholera vibrio, but, on the other hand, "reactivation" of this serum, after inactivation by heating it to 55° C could be brought about by the addition of normal serum obtained from animals of other species, it came to be believed, firstly, that whilst the alexin was a body normally present in blood serum, the substance sensibilisatrice or sensitizing substance was only formed in the serum following immunization; and, secondly, that whilst the sensitizing body would increase in quantity during immunization, the amount of alexin present remained practically unaltered. Later on, Bordet, in 1898, showed that the formation of lysins could be produced in response to the injection into the animal body of cells other than bacterial, and showed that by the injection into an animal, say, for instance, a rabbit, of blood of an animal of different species, say, a sheep, there was produced, after a certain time, in the serum of the rabbit, the power of dissolving the corpuscles of the sheep. The action of this hæmolytic serum resembled that of the bacteriolytic serum before-mentioned, inasmuch as the hæmolytic serum thus prepared could be inactivated by heating to 55° C, but could be reactivated by the addition of fresh serum; and, further, the action was seen to be almost completely specific, the dissolving action being most marked on the corpuscles of the sheep, though it might be noted in a lesser degree when the blood of an animal of closely-allied species, such as the goat, was used.

After the production of bacteriolytic and hæmolytic sera had been established, other workers found that they could produce other cytolytic sera by using for purposes of injection, instead of bacteria or red blood cells, the cells derived from certain other parts of the body. Thus, for instance, a leucolytic serum acting on the leucocytes was obtained by using either lymphatic glands or blood leucocytes as antigen, a spermatolytic serum, by injecting spermatozoa from a bull into a guinea-pig, and a tricholytic serum in response to injection of ciliated epithelium. Organolytic sera were also sought for, and certain of them produced, which had a direct effect on the organ against which they were prepared, following introduction into the body of an animal of the same species as that from which the organ was derived; and, in some cases, though the reaction was specific as far as the species of animal was concerned, it was not anatomically so; thus a nephrolytic serum prepared against kidney substance could also be hæmolytic for the red blood cells, and also leucocytic, as well as being lytic for the kidney cells, since, in injecting the kidney emulsion into animals, to produce the serum, there was unavoidably injected with it a certain quantity of blood. Nevertheless, a hepatolytic serum was obtained by Delezenne in injecting dog's liver into a duck, and a gastrolytic serum for the gastric mucosa was obtained by Bebes and Bolton, which serum could cause even perforation of the stomach wall. Thus, it will be seen that the formation of lysins is a fairly general process, and not necessarily only seen following the injection of bacteria or red blood cells.

It may be noted here that of Hæmolysins we recognise two varieties. Thus, when in an animal of one species a hæmolysin is formed for the red cells of an animal of another species, we speak of it as a hetero-hæmolysin; but Ehrlich found that an iso-hæmolysin could be produced in an individual of one species by injection of blood of another individual of the same species, in the case of goats.

These facts are of immense practical importance, for, in the production of certain anti-sera, for instance, horse-sickness antiserum, in which the blood containing the virus of the disease is transfused from one equine into another, it was found by Theiler that certain individuals formed these isolysins. It was found also that not alone were isolysins produced by using animals of the same species, but also those of closely-allied species, such as the horse, and ass, and also their hybrid, the mule.

Thus individual horses hyperimmunized with horse or mule blood produced a serum hæmolytic for the red corpuscles of horses and mules.

Similarly some mules, when hyperimmunized with mule or horse blood, produced a serum hæmolytic for horses and mules, and donkeys, when hyperimmunized with horse blood, in some instances yielded a serum hæmolytic for horses and mules.

The use of such serum for immunizing equines against horse-sickness is thus prohibited, since its injection into equines would be followed by results of a disastrous nature, ranging from the production of hæmoglobinuria (resulting from the hæmolysis occurring *in vivo*) up to the death of the animal, depending on the amount of isolysin present in the serum. A serum containing these isolysins is not necessarily hæmolytic for the corpuscles of *all* the individuals of the species on whose blood it acts.

These isolysins were never found to be produced in the case of cattle used for producing anti-rinderpest serum. Lately, Todd and White have found, however, that if guinea-pig complement be added to such serum, it can then take on a hæmolytic action for ox blood cells.

It was Ehrlich and Morgenroth who came to study the nature of the lysins more in detail and to investigate the nature of alexin and the other specific body formed in the blood of animals used for the preparation of the lysins. These two bodies concerned in lysis have received various names. Thus the alexin of Bordet (a term originally suggested by Buchner, who applied it to the bactericidal agent in serum of normal animals, regarding it as being of the nature of a ferment) was called complement by Ehrlich, and was also termed cytase and addiment by others, whilst the "substance sensibilisatrice" of Bordet came to be termed amboceptor by Ehrlich; and names such as copula, intermediary body, interbody, immune body, preparator, fixator, etc., were applied by others.

The terms alexin and substance sensibilisatrice of Bordet, and complement and amboceptor of Ehrlich, indicate the difference in the views of these workers and their followers, regarding the actions of lysins.

Ehrlich and Morgenroth, investigating the action of hæmolytic serum, found that if such a serum was brought in contact with the appropriate corpuscles at a temperature of 0° C, no hæmolysis occurred at this temperature, and that if this mixture, kept at this low temperature, was centrifugalised, the resultant supernatant fluid, when removed, was capable of reactivating a hæmolytic serum previously inactivated by heating to 55° C, thus acting as a normal serum would; whilst if the corpuscles remaining, after centrifugalizing the mixture, were suspended in a physiological salt solution (.85 % or .9 % sodium chloride in water) and exposed to a temperature of 37° C, they did not undergo hæmolysis until a supply of fresh normal serum was added.

As a result of their experiments, they concluded that the substance sensibilisatrice of Bordet, which they now termed amboceptor, was capable of combining with the red corpuscles at 0° C; whilst the alexin or, as they termed it, complement, was only able to enter into the hæmolytic action at a higher temperature, and that through the amboceptor—behaving as a link—the complement acted on the cell. Bordet and others, however, maintain that the sensibilizing substance acts more in the nature of a mordant on the cell, the combination thus formed showing a marked affinity for alexin, the whole phenomenon probably being explained as an adsorption of alexin molecules by the molecules of the combination of antigen and sensibilizing substance. Although we are still accumulating evidence as to the site of origin of immune-bodies, and have some facts pointing to the spleen, lymphatic glands, and bone marrow as being their possible sources of formation, yet their production in general was explained by Ehrlich, according to his theory, by supposing that the body cells were possessed of receptors of different types, and that, in the case concerned, the receptor which, when cast off from the cell, constituted the amboceptor, had two combining affinities, one cytophile by which it combined with the cell undergoing cytolysis, and the other complementophile, by which it entered into union with the complement.

As to the source of alexin, it is held by Metchnikoff that it is derived from the leucocytes, and he, who terms it cytase (regarding its cytolytic actions as being similar to that of a ferment, being aided in its ferment action by the immune body, which he calls fixator), holds that there are two varieties of cytase, one a *macro-cytase*, derived from large mononuclear leucocytes, acting chiefly on animal cells; and the other, a *micro-cytase*, derived from the polymorphonuclear leucocytes, acting especially on bacteria, and believes that these only escape into the blood fluid after solution of the leucocyte or, as it is termed, phagolysis.

But whilst Metchnikoff recognises only two forms of alexin or cytase, Ehrlich is of the opinion that there are several varieties, each having an affinity for particular varieties of cells, whilst Bordet upholds the theory of the existence of only one form of alexin in the blood, bringing forward as his argument the occurrence of the Bordet-Gengou phenomenon or "fixation of the complement" reaction.

Whilst the limitations imposed by time and the nature of this paper do not allow of the experiments of the different workers in support of their different theories being brought forward, we shall see, later, how the Bordet-Gengou phenomenon has come to assume great importance in sero-diagnosis.

Agglutinins.—To these bodies we must now pay some attention. They were noted by Gruber and Durham in 1896 when studying Pfeiffer's phenomenon, and they found that if the serum of an animal immunized against the cholera vibrio was added to a culture of this organism in bouillon, the effect was to produce a sedimentation of the bacteria growing in the broth, the organisms forming into small masses, which fell to the bottom of the vessel, leaving the fluid, in which they had been previously suspended, quite clear instead of possessing a turbid appearance.

The substances in the serum producing this action on the bacteria they named agglutinins, since they differed from the lysins, inasmuch as they resisted the effects of heating at 55° C. and when the agglutinating effect was destroyed by the effects of higher temperature, it could not be restored by the addition of the complement present in fresh serum.

It was Widal and Grünbaum who, in 1896, showed that this phenomenon could be made use of in a practical manner to demonstrate the presence of agglutinins in the serum of patients in the early stages of typhoid fever. We shall see later how the agglutination test is applied in practice, but before leaving this part of the subject, we may examine the action of these agglutinins a little further.

It was, later, found, that these agglutinins could be called into existence by the injection of many other varieties of bacteria than those mentioned (the quantities produced varying with the particular species used), and even by the use of red corpuscles, the bodies formed in this latter case being known as hæmagglutinins. The agglutinins are relatively thermostable, resisting, as before noted, the effect of a temperature of 55° C. and some even withstanding heating to 65°—70° C. The reaction between the substance (agglutinogen) giving rise to the agglutinating bodies, and these latter was explained by Ehrlich, according to his side-chain theory, by assuming that the agglutinin was composed of two molecule groups, one of which is haptophore, combining with the body, agglutinated, this action being brought about by the other molecule group of the agglutinin. There is much evidence, however, in support of the view that the reaction is of a chemico-physical nature; and Bordet, who showed that the presence of sodium chloride was necessary for the occurrence of the reaction, holds the idea that it can be explained by assuming that the surface tension of the liquid, in which the combined agglutinating and agglutinable substances are suspended, acting on this complex, brings the particles together, when, in obedience to gravity, they settle to the bottom of the liquid. There are many who consider that the action of agglutinins is directly comparable with that of the next class of antibodies to be considered.

The Precipitins.—These were first described by Kraus in 1897, who found that the serum, derived from animals immunized against the organisms of plague, cholera and typhoid fever could, when added to the filtered fluid in which cultures of these organisms had been growing, produce a precipitate in the liquid.

Observations in this direction being extended, it was found that this reaction could be induced by the serum of animals immunized against other kinds of albuminous material, when their serum was added to solutions of these materials, such as blood-serum, milk, muscle-extracts and albuminous urine, to mention only a few substances used for this purpose. Thus the test came to have a great diagnostic value, not so much, however, in the realms of bacteriology as in those of human forensic medicine and also the inspection of meat, where the "precipitin method" of diagnosis is applied to the detection of the nature of blood-stains on clothing, etc., in the one case, and to the detection of falsified flesh in the other. The precipitins are, like the agglutinins, relatively thermostable, resisting heat to about the same degree, and the remarks made as to the action of the agglutinins apply to them as well.

We still have to consider that class of antibodies concerned in the so-called opsonic action, and which are known as Opsonins, since it is thought by Wright that, by their action on the organisms entering the body, these latter are rendered more susceptible to ingestion by the leucocytes, by reason of their increased attractiveness. Metchnikoff looks on immune serum as increasing phagocytic action rather by stimulation of the leucocytes than by its action on the bacteria. Wright's experiments, however, led him to think that these opsonins acted in the before-mentioned manner on the bacteria of certain affections, and more notably on staphylococci, streptococci and the bacillus of tuberculosis. He also thought that these opsonins were distinct and specific antibodies, and that their presence was absolutely necessary for phagocytosis to occur.

Some other workers think they are not a distinct form of antibodies, and Lohlein pointed out that the leucocytes were capable of performing their phagocytic action when washed and thus freed of serum altogether; but there are still others who go so far as to attribute to the opsonin the possession of a combining group on which their action depends, and since, after inactivation by heat, the opsonic action is not restored by the addition of complement, they regard them as receptors of a similar nature to agglutinins and precipitins.

Wright holds that the quantity of these opsonins in the blood may be taken as a measurement of the degree of the immunity of the individual towards infection by certain organisms, such as those above mentioned and some others, and has brought vaccine therapy into extensive use once more in the case of certain bacterial infections, urging that this method of treatment is of great value when controlled by measurements of the opsonic index. In the hands of others, however, the method has not given the results claimed for it by Wright and his school. The method of examination for the presence of opsonins may be briefly indicated here. It consists in bringing into contact a suspension of leucocytes in physiological salt solution (in which fluid these leucocytes have been previously washed) with the bacteria on which their phagocytic power is to be estimated, and to a part of the mixture of the leucocytes and bacteria we add the serum of the subject to be examined, whilst to another portion of the same mixture we add the serum of a number of individuals taken to represent the normal. We incubate these mixtures at 37° C for a certain time and then, having made and stained films from these mixtures on glass slides, we count the number of bacteria which have been ingested by the leucocytes which have been mixed with the serum of the subject for examination, then estimate the average number of bacteria ingested by one leucocyte in this mixture, and make a similar determination in the case of the mixture containing the serum of the normal individuals. The average number found from the former calculation divided by that found in the latter instance indicates the opsonic index of the subject.

It may be mentioned here, before we pass on to see further how the presence of various antibodies may be utilised to establish a diagnosis of certain infections, that the action of these antibodies cannot be said to be *absolutely* specific. It is well known, for instance, that agglutinins, lysins, and precipitins, may exert their action not alone on the antigens against which they are prepared, but also on those of closely-allied origin.

Thus a serum hæmolytic for the corpuscles of the horse or sheep may also act on the ass or goat in the respective instances, or a serum agglutinating one species of bacterium, as, for instance, the typhoid bacillus, may also agglutinate members of closely-allied species such as the bacillus coli, and paratyphoid organisms this constituting the so-called group re-action. Similarly, a prepared serum causing a precipitate with the serum of an animal like the rabbit, may also cause precipitate formation with serum of a hare.

It is the case however, that the most marked reaction occurs between the antibody and the specific antigen producing it and we minimise to the greatest extent possible the error due to group reactions by bringing the antibody into contact with the antigen under conditions of marked dilution, or sometimes by using an absorption method.

It must also be said that sometimes, in utilising sero-diagnosis, cases are met with where the serum of the normal individual may give certain reactions, as, for instance, in the case of the serum of the horse, which, normally, has an agglutinating effect on the bacillus of glanders, which only disappear from evidence on dilution of the serum.

The practical value of this method of diagnosis is evident in the case of those diseases where a direct demonstration of the causal organism of the injection may either be impossible, or possible only with difficulty at the time of the examination of the animal, as in cases of occult glanders in the horse; or contagious abortion in cattle; or infection with the *micrococcus melitensis* of the goat.

At the same time, there are certain limitations imposed on the demonstration of the present or previous existence of specific antigens in the animal body through the examination of its serum for specific antibodies, and these limitations are, in some cases, due to the fact that the antibodies are present in too small a quantity to be detected by our present methods, and, in others, to the difficulty in obtaining a suitable preparation to act as the antigen necessary for the performance of the tests.

The sero-diagnostic methods which have found the most common usage in veterinary medicine up to the present time, are the methods of agglutination, precipitin-formation and complement fixation.

General technique of these methods.

In the performance of the agglutination test, in order to demonstrate in the serum of the subject the presence or otherwise of agglutinins formed in response to the presence in the subject's body of the causal agent of the infection acting as an antigen, there is necessary:—

(1) The antigen, which is an emulsion of the organisms suspected of causing the infection.

(2) The serum from the subject.

The emulsion of the organisms is sometimes made from a fluid culture, but most often from a culture grown on some suitable solid medium, agar, or some of its modifications, being usually employed. A young culture of the organism growing on the solid medium is scraped off and emulsified in physiological saline solution, to which, in many cases, a bactericidal agent is added, in order to kill the bacteria, since the reaction can occur even when these are dead. The emulsion must, of course, be uniform and contain no clumps, this latter being ensured by being careful, in making the emulsion, to rub up the organisms well in the fluid, to remove the clumps of bacteria, which is usually effected by centrifugalizing the mixture for a short period, and also to make it of a determined suitable density, which is usually ascertained by comparison with a standard emulsion.

The serum from the subject is obtained by withdrawing the blood in a sterile manner from one of the veins—most often the jugular—and when it has coagulated, the serum is collected. This serum is now, in varying dilutions, brought into contact with the emulsion of the organisms, and evidence of agglutination may be sought for either according to the microscopic or macroscopic methods. In the first, the mixture of bacterial emulsion and serum is examined as a hanging drop preparation under the microscope, and the reaction may be clearly seen in the formation of clumps or groups of the bacteria in the drop of fluid, in which they were in uniform emulsion at the commencement of the reaction.

The macroscopic method consists in placing the solution of serum in different dilutions, together with the antigen, in small test tubes, when the reaction manifests itself by the formation of small flocculi, which fall to the bottom of the tube, forming small heaps, and leaving the fluid in the tube quite clear instead of turbid as it was when the mixture was first placed in the tube.

In making the precipitin test for diagnosis of infection by a specific pathogenic agent, it is necessary to have either an extract of this agent or a filtrate of a liquid-medium in which it has been growing. This is added to the serum for examination, the addition being made in a number of different dilutions in very small test tubes, and the reaction consists in the production of an opalescent appearance where the two fluids come in contact or the formation of a precipitin.

The "complement fixation" method of diagnosis is based on the idea that if an antigen is brought into relation with its suitable specific antibody when the latter is present in an inactivated serum, and complement be added, then this complement becomes fixed to the antigen through the medium of the specific antibody and hence, being fixed, is no longer available to reactivate a previously inactivated hæmolytic serum, which is added in the presence of a suspension of the corpuscles against which this hæmolytic serum is prepared.

Thus it will be seen that for the performance of test there is necessary:—

(*a*) The antigen. This may be a bacterial extract, or a solution containing the products formed by the organism in its growth, or, perhaps, an extract of an organ in which the causal agent is present.

(*b*) The serum of the subject to be examined.

(*c*) The complement, obtained by using the recently-obtained serum of some suitable animal.

(*d*) The hæmolytic serum obtained by injecting repeatedly an animal of one species with the blood of that of another species. Sometimes the hæmolysins normally present in the serum of the subject to be examined are made use of instead.

(*e*) A suspension in a suitable fluid, such as physiological salt solution (.85 % to .9 % sodium chloride in water) of the red corpuscles, against which the action of the hæmolytic serum is directed.

In describing the method of application of the "complement fixation" test, it is perhaps best to take a special example as an illustration, say, that of the diagnosis of glanders.

In this case the hæmolytic serum used is usually that of a rabbit which has been repeatedly injected with the blood of another animal, which is very often a sheep. Blood is taken from the jugular vein of the sheep, defibrinated, and must be washed repeatedly in a physiological salt solution so as to remove any serum adherent to the corpuscles, as otherwise antibodies reacting with this serum might be produced which would interfere with the test. When, after repeated injections, it is thought that the rabbit serum is hæmolytic to a high degree, it is obtained either by bleeding the animal from the ear or by bleeding it to death from the carotid artery, and then it is tested in order to find the smallest amount which is capable of producing the hæmolysis of a given amount of corpuscles.

In the titration of the serum the following method is used: If the rabbit serum is fresh at the time of testing, it must be inactivated by heating it in a water bath for half an hour to one hour at 56° C before the test is applied.

A series of test tubes is then taken and a fixed quantity, usually 1 cc of the inactivated rabbit serum in different dilutions, say, 1-10 to 1-5,000, is placed in each tube. Then there is added to each tube an excess of complement, most often a quantity of 0.5 cc of a 1-10 solution of guinea-pig serum in physiological salt solution being used. To this mixture we further add in each tube 1 cc of a 5 % suspension of red corpuscles of the sheep in physiological salt solution. Control tubes to show that neither the rabbit serum, nor the guinea-pig serum, nor the salt solution, is by itself capable of producing hæmolysis, are also employed. Finally, the volume of all the tubes is brought up to uniform standard by the addition of physiological salt solution, and the tubes, after shaking, are placed for two hours in an incubator at 37° C. The smallest quantity of the rabbit serum producing complete hæmolysis of the corpuscles at the end of this time indicates the titer of the serum and, for the proper performance of the test, this should be very low. We use twice this quantity in applying the test.

Next it is necessary to find what is the smallest amount of the complement used which is capable of producing the complete hæmolysis of the standard amount of sheep corpuscles in the presence of twice the smallest quantity of hæmolytic rabbit serum which caused complete hæmolysis of the corpuscles in the last test. The complement, as before-mentioned, is obtained by using guinea-pig serum, and this must be used relatively soon after it is obtained since its activity gradually decreases on keeping and ultimately disappears. The titration is carried out on the same principle as before by taking a series of test tubes, to each of which is added 1 cc of a solution containing the previously determined necessary amount of rabbit serum, then 1 cc of 5 % suspension of sheep's corpuscles, then the complement in varying quantities, and finally the volume of fluid in the tubes is made uniform by the addition of physiological salt solution. The same control tubes are used as in the previous test. All of these tubes are shaken, placed in the incubator at 37° C for two hours and then examined. In this case the tube which shows complete hæmolysis of the contained corpuscles indicates the smallest quantity of complement which, in the presence of the determined amount of hæmolytic rabbit serum, is capable of producing complete hæmolysis of 1 cc of a 5 % suspension of sheep's red corpuscles in physiological salt solution inside two hours at 37° C. The antigen is an extract of the glanders bacillus (*B. mallei*) made from a young culture which has been grown on some solid medium, such as glycerin-potato-agar. The extract is made in physiological salt solution, to which has been added a small quantity (.5 %) of carbolic acid as a germicide. In the case of the antigen we must also determine by titration what is the most suitable quantity to use, since we know that if present in too large quantities it may directly combine with some of the complement; hence we must find the largest amount which will not interfere with the production of complete hæmolysis by the quantities of complement and hæmolytic serum before determined, and, in applying the test, we use half of this amount of antigen.

The titration of the antigen is based on the same principles as the previous titration tests, the quantities of complement, hæmolytic rabbit serum, and blood, present in the tubes being constant and the quantity of antigen varying according to the dilutions in which it is added. Another control tube is necessary in addition to those used in the previous tests, in order to show that the antigen itself has no hæmolytic action. The tubes are now incubated as before and, on examination, the first tube of the series showing complete hæmolysis of the contained blood indicates the largest quantity of antigen which does not interfere with hæmolysis, and we use, as above-mentioned, half of this quantity in the final test.

In making the test proper the following procedure is adopted:—

The serum from the horse to be examined is obtained by withdrawing a small quantity of blood, the serum being collected after coagulation. This serum is now inactivated by heating for about half an hour from 58° to 62° C. Heating at the higher temperature seems to have an effect in reducing the quantity of certain non-specific bodies in the horse serum, which can fix a certain amount of complement by themselves and may, if not destroyed, interfere with the test.

Now, we take four tubes and in these we place the complement in the determined amount, and to the first two we add .1 cc and to the second pair .2 cc of the serum to be tested. Then to one tube of each pair we add the previously determined suitable dose of the antigen. The volumes of the fluid in the tubes are then made up to a certain fixed quantity, and the tubes are placed in the incubator at 37° C for one hour. If the specific glanders antibody is present, the complement should now, through its medium, combine with the antigen, and we see if this has occurred by placing in each of the tubes, at the end of the hour, the already estimated suitable amount of inactivated hæmolytic serum and, along with it, 1 cc of the 5 % suspension of sheep's red corpuscles in physiological salt solution. The tubes are now shaken and again placed in the incubator, at 37° C, for two hours. The necessary controls for the complement, inactivated hæmolytic serum, antigen, and physiological salt solution are, of course, also employed. Now the tubes are removed from the incubator and put aside for some time in a cool place, in order that their contents may settle, and then the reading of the test is made.

If no hæmolysis has occurred in the tubes to which the antigen was added, it indicates that the complement has entered into union with the antigen, and that none is left free to combine with the mixture of inactivated hæmolytic serum and sheep's corpuscles subsequently added; but, as it can only do this when the specific glanders anti- or immune-body is present, we conclude that the horse is affected with glanders. In the tubes to which no antigen was added hæmolysis should occur, and they are merely controls to show that the serum of the subject by itself does not prevent or interfere with the occurrence of hæmolysis.

This method of diagnosis by complement fixation has proved of great value in the case of glanders, in the diagnosis of which it is sometimes applied exclusively, but perhaps most often in combination with the agglutination test, and the precipitin test is sometimes used in addition to these other two. In some places the methods of complement fixation and agglutination have replaced the use of mallein, but it must be remembered that they are purely methods which can only be carried out by workers in laboratories.

The practical use of these methods has also been indicated in the case of contagious abortion in cattle. The agglutination test is of service also in the diagnosis of infection of the domestic animals, and more especially the goat, with the *micrococcus melitensis*, the causal agent of Malta or Mediterranean fever of man. Here it may be remarked that Bruce has shown that the disease known amongst the natives of Uganda as "Muhinyo" is the same as Malta fever. It must be pointed out here that by these methods not alone can we demonstrate the presence of specific antibodies when we are in possession of their respective antigens, but that also we can reverse the process when we possess a serum containing specific antibodies, in utilizing it to demonstrate the presence or otherwise of their antigens; and this method is made much use of in the laboratory in determining the relationships of bacteria derived from different sources, or of bacteria which are morphologically very similar and whose species are not easily distinguished by cultural methods, such as those of the typhoid, para-typhoid, colon groups and others.

It is of interest here to note that Ascoli and Valenti have comparatively recently applied to the diagnosis of anthrax a form of the precipitin formation test which is said to be of great value in diagnosing this disease, being, for all practical purposes, of a specific nature; and, further, advanced decomposition or marked putrefaction of the carcase from which the material to be examined is obtained seems to make no difference as far as the value of the test is concerned.

The above-mentioned methods are those which have, up to the present time, been extensively used in pathological diagnosis; but it is hardly justifiable to conclude this paper without reference to some other methods whose value we can not yet properly estimate, since much more experimental work must be done before their every-day use can be justified. One of these methods is that of diagnosis by means of utilization of the phenomenon of Anaphylaxis. This term is one created by Richet in 1902, and indicates a condition the opposite of that of protection, and, in which the organism manifests a state of increased sensibility to a second introduction under certain conditions, of materials which exerted no, or only very slightly, harmful effects at the time of the first inoculation.

Richet was working at the time chiefly with a toxin (actino-congestin) obtained from the tentacles of the marine animal *Actinia*, and found that when he injected into dogs doses of this toxin from which they recovered, that a second injection of the same material, used after a certain time and in a much smaller dose than that used on the first occasion, could cause their death, and in most cases their death occurred almost immediately after this second injection.

Oher workers, such as Arthus, made similar observations as to the increased sensibility shown to horse serum by rabbits, and the "Theobald Smith phenomenon," which is manifested by an increased sensibility of guinea-pigs to secondary injections of mixtures of diphtheria toxin plus antitoxin, was shown by Rosenau and Anderson to be dependent on the presence of the horse serum containing the antitoxin, and not on the toxic nature of the mixture, since the horse serum alone was capable of producing the same symptoms as those produced by the toxin-antitoxin mixtures.

Since then it has been shown that the anphylactic condition can be produced in the presence of most of the members of that class of organic substance which we have termed antigens.

If we illustrate these remarks by an example, for instance, the injection of a guinea-pig, with a foreign proteid such as horse serum, we find that on injecting this material on the first occasion it has no appreciable effect. When, however, a certain time, roughly, about 7 to 14 or 21 days, is allowed to elapse, and then a second injection of the same material is made, it is capable of producing marked characteristic symptoms and death of the animal either immediately after or almost immediately after this injection, depending on the route by which the material is injected.

It was further shown that not alone could an active anaphylaxis be thus produced, but that also a passive anaphylaxis could be conferred on another animal by injecting it with the serum of an animal in a condition of active anaphylaxis, this second animal reacting to the introduction of the material against which the anaphylactic condition was produced in the first animal, after an interval of about 24 hours, and in a similar fashion to the actively anaphylactic animal.

Generally speaking, the anaphylactic reaction is specific, though not absolutely so, since it occurs in the presence of proteids of closely-allied natures.

If we wish to utilise the amphylactic reaction for diagnostic purposes, we can attempt to use it in two different ways, either by a direct method, where we inject into the subject to be examined a small quantity of antigen similar to that we suspect to be present in the subject's body, and noting whether the subject shows an anaphylactic reaction or not to the introduction of this antigen; or, on the other hand, we may take some of the subject's serum, inject it into another animal and then by injecting this animal with the suspected antigen, find whether or not we have been able to confer on this animal a passive anaphylaxis.

As before-mentioned, however, these methods have not been tried to a sufficient extent to allow us to judge their real value. Lately, Miessner has applied the last-mentioned method to the diagnosis of glanders, but the results were negative in this case.

We can, unfortunately, not enter into any further details concerning anaphylaxis, but it may be noted here that Von Pirquet and Schick explain the symptoms of the "serum disease" of man as being manifestations of anaphylaxis to the serum, and many regard the reaction to tuberculin and mallein as being capable of explanation on similar lines.

There are still some other methods to which attention must be paid. One of these is a method of diagnosis lately described by Forgeot and Caesari and used by them in the diagnosis of ulcerative lymphangitis of the horse. This disease is due to infection by the Preisz-Nocard bacillus, an organism which is also responsible for the production of Caseous pneumonia and Caseous lymphadenitis in sheep, as well as certain abscesses in the lungs of calves. The technique they employ is to inject the serum of the subject for examination into the gastrocuemius muscles of a guinea-pig and on the following day this animal is injected subcutaneously with a solution containing the Preisz-Nocard bacilli, which have been killed and extracted with a mixture of alcohol and ether.

Two control animals are inoculated at the same time. One of these receives an injection of the bacilli alone and the other is inoculated in the same manner as the test animal, but receives an injection of normal horse serum in place of the subject's serum. If the subject for examination is affected with the disease, then the guinea-pig inoculated with the bacilli and the serum of the subject shows no local reaction at the site of injection of the bacilli extract or, at most, only a minimal scar formation, whilst the control animals should die proving the toxic effect of the bacilli extract.

Another method we might mention is that suggested by certain workers who have thought it possible to utilize, in the diagnosis of cancer, the isolysins which are present in the blood of certain individuals affected with this disease. The percentage of successes with this method in human medicine is, however, not very high and appears to be even less when the test has been used in the case of some of the domestic animals.

There is a method, however, which has been introduced by Ascoli and Izar which has given very encouraging results in diagnosis, especially in the case of malignant tumours and epizootic aphtha (foot-and-mouth disease), and in the human subject, in the case of syphilis, malignant tumours, echinococcosis, and some other diseases. This method is the so-called "Meiostagmin-reaction," which depends on the fact, that when a serum containing a specific antibody is brought in contact with a solution of its respective antigen, and the mixture is kept at 37° C for two hours or 50° C for one hour, there occurs a decrease in the surface tension of the mixture of the two solutions, and this decrease of surface tension may be measured by estimating the number of drops formed when the liquid is dropped from a Traube's stalagmometer. This number is compared with the number, obtained in a similar manner, but using a normal serum mixed with the antigen, and by thus estimating the difference in surface tension between the two liquids one may arrive at a diagnosis.

This concludes our review of the methods of sero-diagnosis applicable to diseases of stock in South Africa, and it is to be hoped that the experiments, being made with the object of applying them to the study of the diseases of this country, may come to a successful issue.

TRANSACTIONS OF SOCIETIES.

Geological Society of South Africa.—Monday, December 9th: Mr. H. S Harger, President, in the chair.—" Note on a composite dyke from the Klipriversberg ": D. P. **McDonald.** The dyke comprises two rock types differing markedly in petrographical characters. A basic magma was first intruded, and on crystallising produced a typical ophitic dolerite. A second intrusive magma is evident in the centre of the dyke as a relatively acid rock of granophyric structure. The absorption of basic material by the acid magma gave rise to hybrid rocks.—" Notes on the vertical bedded veins of Pilgrim's Rest ": A. **von Dessauer.** All these vertical veins and dykes resulted from one continuous tectonic movement; they were evidently intruded after the deposition of the whole Transvaal System. At all horizons where vertical veins or dykes are found bedded reefs occur. There is a genetic connection between the vertical and bedded reefs, the former being the feeders of the latter. Mineralisation is due to post-volcanic agencies.—" Negative spheroidal weathering and jointing in a granite of Southern Rhodesia ": Dr. P. A. **Wagner.** The Greystone Hills have been carved out of a boss of porphyritic granite, covering an elliptical area of 6½ by 2 miles. The granite is remarkably uniform in texture, notwithstanding which the hills show great diversity of configuration, due solely to the differences in the nature and disposition of the natural divisional planes traversing the rocks. These are (1) platy joints or curvilinear cracks of huge radius, (2) systems of well-defined vertical and horizontal joint planes, (3) concentric spheroidal joints. The author proceeded to discuss the influence of these various types of jointing on the hills constituting the Greystone Range.

South African Institute of Electrical Engineers.—Thursday, December 19th: J. H. Rider, V.P.I.E.E., President, in the chair.—" Electrical distribution for mines ": J. W. **Anson.** The author discussed various questions which require consideration when an existing reduction plant in connection with one of the Witwatersrand gold mines has to be electrified, or when the electrical equipment of a new reduction plant or process has to be designed.—Thursday, January 16th: Mr. J. W. Kirkland, President, in the chair.—" The education and training of engineers ": N. **Harrison.** The view was expressed that the policy of importing engineers should cease, and that methods of training intending engineers should be introduced which would make the country self-contained. The author further dealt with the functions of an engineer, with the past and present provision for training engineers, concluding with suggestions for future action in this connection.

NEW BOOKS.

Worsfold, W. B.—*The Union of South Africa: with chapters on Rhodesia and the Native Territories of the High Commission.* 8vo., pp. ix., 530. Map and illus. London: Sir Isaac Pitman & Sons, 1912. 7s. 6d.

FitzSimons, F. W.—*The Snakes of South Africa: their venom and the treatment of snake bite.* 8vo., pp. xvi., 547. Illus. Cape Town: T. Maskew Miller, 1912. 42oz., 12s. 6d.

Johnson, J. P.—*The prehistoric period in South Africa.* 2nd Edition. 10 × 7½ in., pp. vi, 116. Illus. London: Longmans & Co. 1912. 10s.

Johnston, Sir H. H.—*Livingstone and the exploration of Central Africa.* Maps and illus. 7 × 4½ in., pp. viii, 372. London: G. Philip & Son, 1912. 1s.

THE MINOR PLANET MT 1911: AND ON MINOR PLANETS IN GENERAL.

By Robert T. A. Innes, F.R.A.S.

It is commonly known that the number of minor planets (or asteroids as they were called by Sir William Herschel) is very large and constantly increasing, and as the Union Observatory devotes some considerable portion of its time to these small bodies, it will not be unfitting to discuss briefly the present state of our knowledge of these minute astronomical objects.

Before any minor planet was known, the existence of at least one had been speculated upon. If the orbits of the six planets known to the ancients are plotted, it is seen that the gap between those of Mars and Jupiter is larger than a certain symmetry required. The idea that such a planet existed with its orbit between those of Mars and Jupiter was first mooted by Kepler. Guided by profound, but totally inaccurate wisdom, the philosopher Kant explained the disproportionate magnitude of the interval as due to the large mass of Jupiter, the zone in which each planet moved being the storehouse from which it was built up. The so-called Bode's law which was discovered by Titius, followed as it was by the discovery of Uranus, whose distance from the Sun agreed well enough with it, clearly indicated that a planet should be looked for between the orbits of Mars and Jupiter; and this opinion got to be held so firmly that, late in the eighteenth century, a co-operative scheme for its search was formed, and one of the chosen observers was Piazzi. But before Piazzi heard of his appointment two remarkable events occurred. One was the qualification of the since world-renowned philosopher Hegel as a *privat-dozent* at the Jena University. His dissertation was on the planetary orbits, and again pure philosophy was able to state that it might be a mistake to look for a planet between Mars and Jupiter. This weighty pronouncement would no doubt have stilled astronomical activity, but, unfortunately for the philosopher, a planet had already been discovered by Piazzi, the tardiness of postal communications in those days being just sufficient to let Hegel's publication and appointment pre-date the news of Piazzi's discovery of some months before by a few days. The first minor planet, Ceres, was thus discovered by Piazzi on January 1, 1891. It created a profound sensation, not unmixed with alarm lest this addition to the solar family should become "lost" before its orbit could be calculated. As is well-known, the mathematician, Gauss, earned his spurs by computing the orbit. It will be seen later how history repeated itself in the case of the planet 1911 MT. Three other minor planets, all travelling between the orbits of Mars and Jupiter, were found by 1807. I think astronomers then considered the zone exhausted. No additions were made until 1845, when Hencke discovered Astrea; henceforward discoveries were made every year until, at the end of November, 1891, no less than 322 of these bodies had been found, and not only found, but also so well followed up that, generally speaking, their orbits were well known; but a few had been "lost." In 1891 Max Wolf, of Heidelberg, discovered No. 323, Brucia, and, as was remarked at the time, it was interesting as being the first new asteroid discovered by photography.

In Newcomb's *Popular Astronomy* (edition 1882) he remarks:—

> "It will be seen that the rate of discovery has been pretty steadily increasing during thirty years. This is not because the number of those visible, but not yet found, is so great that it is as easy as ever to find one, but because they are now sought after with more skill and system than formerly. . . . Professor Peters, in searching for these bodies, falls upon several already known for every new one that he finds. Consequently, were they all lost, he alone could re-discover them at a more rapid rate than they actually have been discovered by the efforts of all the observers engaged in the search. . . . The number of these bodies now known is so great that the mere labour of keeping run of their motions, so that they should not be lost, is out of proportion to the value of its results. It is mainly through the assiduity of German students that most of them are kept from being lost. Should many more be found, it may be necessary to adopt the suggestion of a German astronomer, and let such of them as seem unimportant go again and pursue their orbit undisturbed by telescope or computer."

Newcomb's remarks were made nine years before Max Wolf's first discovery, and, as far as I know, he never referred to the subject again. In 1893 it was announced that no minor planet would be given a permanent number until five observations were available, but to-day a permanent number is not given until observations spread over six weeks are available and a satisfactory orbit is computed. In 1893 the provisional designation by the year and a letter, which is still in force, was adopted, so that the record of discoveries in that year started with 1893 A and finished with 1893 AP. And so matters went on until 1898, by which time the lettering had got to ED and the permanent numbers to 436; but one discovery, in 1898, produced a great sensation, the discovery by Witt, at Berlin, of the minor planet Eros, whose mean distance is less than that of Mars and which can approach the Earth with 0.149 of the mean distance of the Sun. The value of this planet for finding the parallax of the Sun was at once seen, and although Eros will not make a very close approach to the Earth until 1931, it was determined to make use of the fairly favourable opposition of 1900. Here it will suffice to say that, on the 9th February, 1912, the Gold Medal of the Royal Astronomical Society was awarded to Mr. Arthur R. Hinks, of the Cambridge Observatory, for his "Determination of the Solar Parallax from Observations of Eros." It will be remembered that almost simultaneously with the discovery of Eros, Sir David Gill published the result of his researches, using observations of the minor planets, Victoria, Iris and Sappho, made in 1888-1889. His value of the parallax was:

$$8''.802 \pm 0''.005$$

Mr. Hinks's is $8''.806 \pm 0''.004$

It will be seen that the two results agree within their respective probable errors.

Here, at last, was a minor planet that repaid many years of searching, but it was curious to remark that it was and is still Dr. Witt's only discovery; one should have expected that the veterans in the field, such as Charlois, Palisa or Wolf, would have secured the prize. At this period minor planets were still largely found by visual observation with ordinary, but, of course, powerful astronomical telescopes. Passing on rapidly, we come to the year 1906, in which no less than 117 new minor planets were announced, every one of which was found by photography. This year was remarkable on three accounts; firstly, for the discovery of the planet since numbered and named 588 Achilles, whose mean distance exceeds that of Jupiter by 0.04; secondly, for the introduction by Dr. Joel Metcalf of the principle of guiding the telescope so that the plate remained approximately at rest with regard to the usual motion of a minor planet, and the stars, instead of appearing as points, are drawn in trails—in this way fainter planets can be photographed; and, lastly, 294 Felicia, which had not been seen since 1891, was refound photographically. Here we have the introduction of another type of minor planet, *viz.*, with a mean-distance nearly the same as that of Jupiter. Since 1906 three other planets belonging to this group have been found, *viz.*, 617 Patroclus, 624 Hector, and 659 Nestor; two members of the group have mean distances slightly less and two slightly greater than Jupiter's, but more remarkable is the fact that they all travel around the Sun, keeping at an angle of about 60° from Jupiter, and, so far, supplying four concrete cases of Lagrange's celebrated theorem on the stability of motion of three bodies situated at the three angles of an equiangular triangle. At the end of 1911 the minor planets permanently numbered amounted to 714, and out of the 50 new planets announced in that year, no less than eight were found visually by the veteran observer, Palisa.

As to the present state of their orbits and ephemerides, the *Berliner Jahrbuch* is, as it has been for years, the chief authority, and it has recently altered the shape in which it prints the ephemerides. Approximate places at four ten-day intervals are given for 563 planets in 1912, that is, practically for all whose orbits are well enough known to permit prediction These ephemerides are rough, but sufficiently accurate to allow ready identifications of objects found. Perturbations will only be computed for planets of special interest. Besides the ephemerides thus published there are a considerable number, in addition, given from time to time in the *Astronomische Nachrichten* and other astronomical journals by astronomers, who happen to be interested in some special planet or group of planets.

It was by no premeditated design that the observation of minor planets was undertaken at the Union Observatory. It was in April, 1911, that Mr. Wood took some long exposure (four hours) photographs of Jupiter, in the hope, which was ultimately realized, of getting images of the very faint eighth satellite of Jupiter. The plates are of large size, being 16 inches square, and cover about 325 square degrees of the sky, the scale being precisely that of Argelander and Schonfeld's maps of the Bonn Durchmusterung. The plates are exposed in the Franklin-Adams 10-inch diameter, 44.6 inches focus, Star-Camera. On examining the first plate he got, Mr. Wood at once noticed numerous trails of minor planets, no less than 15 in all, of which five were new—this being the largest single haul yet accomplished. When this was known in Europe, it was soon recognized that at last an observatory in the Southern Hemisphere was in a position to aid not only in the discovery, but in the equally, or perhaps more, important work of following up and identifying planets at oppositions which would be invisible to astronomers of the Northern Hemisphere. Thus we were requested by cablegram to obtain positions of the Jupiter-group planet 624 Hector in 1911. It was then in South Declination 43 degrees and below the 13th magnitude. At the same time a similar message was sent to the Royal Observatory at the Cape. Hector was accordingly photographed at both observatories, but the way in which the one observatory helped the other is somewhat remarkable; in the *Astronomische Nachrichten* for September 5, 1911, Mr. Hough tells us how plates were taken with the Astrographic telescope on July 4 and subsequent dates with a view to searching for the planet, and although a preliminary search failed to reveal the planet, it was found on these plates after the corrected position had been notified from Johannesburg. Although we very certainly photograph any object anywhere near its predicted position, our positions are not very exact because of the small scale of the photographs, but they are more than sufficiently exact to indicate the precise place to other observatories with superior equipment in this line. In the case of such an interesting planet, the Cape observations have already been utilized in the preparation of the ephemeris for the next opposition, and it is on the list for re-observation in a few weeks' time.*

One may say that now the lookout is for minor planets of the rarer classes, and that the great desideratum is to be able to discriminate readily betwixt the commonplace and the rare. The great group of minor planets circling between Mars and Jupiter is capable of much sub-division. There are, first, the four oldest-known, which are much the largest, Ceres, Pallas, Juno and Vesta; these and some others will be observed at many observatories with every precision and their theories worked out with every care. Secondly, there are the planets whose periods are near to a sub-multiple of the period of the massive Jupiter, of which Hecuba, whose period is closely but not exactly half that of Jupiter, may be especially cited; this species gives rise to refined

* Hector was duly observed here on the 6th and 10th of August, almost exactly in its predicted place. The observations were published in the *Astronomische Nachrichten*, No. 4602, and appear to be the only ones obtained at the last opposition.

and difficult problems of planetary motion. Then there are the classes of very great excentricity or of great inclination, which give rise to other problems, and so on. The only other groups at present known are the Jupiter 60° group and Eros, but Professor E. W. Brown considers that there may be Jupiter 22½° planets, and, if instruments were powerful enough, astronomers might find a Saturn group of planets.

It is very desirable that the minor planets should be observed at every opposition, but this would be impossible without organized effort, and that is now being made. At, I believe, the initiative of Dr. F. Cohn, of the *Berliner Jahrbuch*, the sky is divided into four zones, three of which are allotted to northern observatories (Heidelberg, Dr. Wolf; Taunton, Rev. J. Metcalf; and Simeis, Crimea, Herr Beljawsky), whilst the southern zone, from —9° southwards, is allotted to the Union Observatory. Very precise positions of the minor planets, except in rare cases, will not be required; from the ordinary observations the orbits of the large number of minor planets will be corrected empirically from time to time, and in this way it is hoped that knowledge of the group will be gradually perfected and that unusual objects may be the more readily picked out.

When referring to the discovery of Eros it was mentioned that this did not fall to one of the veterans, of whom Herr Palisa is to-day the chief; but recently he has had his compensation. I do not mean that the astronomical world has overlooked his whole-hearted devotion to this branch of astronomy, his precise and long-continued visual observations and his numerous discoveries, or that the valuable Wolf-Palisa star-charts are not appreciated. I mean that it is a compensation when long-continued and faithful work is rewarded by a rare discovery. Herr Palisa's discovery of 1911 MT and its subsequent story has some resemblance to the discovery of Ceres by Piazzi. Palisa discovered this object on the night of October 3, 1911, and he observed it again on the following night. Its unusual motion at once arrested his attention, and he telegraphed for further observations to all likely stations. Instead of the object's Right Ascension decreasing whilst in opposition, it was increasing, which at once stamped it as extraordinary. Fortunately, as a result of Palisa's message, Pechule, of Copenhagen, managed to measure the object's position on the night of October 4. After that date clouds and moonlight interfered to such an extent that the object was not seen again. Palisa had faith in his observations, and cabled to us to photograph the region, and Mr. Wood did so on the nights of October 13, 14, 16, 18 and November 15, but we also suffered from the atmosphere, and the only excellent plate was that of October 18. It was duly searched, and a new planet found, which was suspected to be MT, but it was a different one, and is at present known as 1911 MU. The remarkable part of the business comes now; the methods devised by Gauss for the computation of an orbit from observations require that the dates of observation in the case of a minor planet should be spread over a few weeks. In this case the observations were spread over only a few hours, and Gauss's method was useless. Let me say here that if exact process seemed to fail, a clever judgment was not so much at fault, because, with only the three observations before him, Dr. Crommelin, of the Greenwich Observatory, wrote:—

"The fact that the second and third observations were on the opposite sides of the meridian enables us to get an approximate value of the distance from the Earth: a distance of 0.18 will make the motion in R.A. uniform when reduced to the centre of the Earth. If we suppose MT to have a perihelion distance the same as that of Eros, an orbit slightly more eccentric than his, with an inclination of some 7°, will satisfy the observations. . . . It is to be feared that MT will remain one of the unsolved enigmas of astronomy."*

But in spite of the ill conditions of the problem, orbits and ephemerides for MT were worked out. One by Herr Franz appeared in the *Astronomische Nachrichten of* 1912 *May* 8, but Herr Franz had kindly sent us an advance MS. copy. Although we know now that the ephemeris was not far out, a search by both Mr. Wood and myself was fruitless. We then received an ephemeris from Professor A. O. Leuschner, of Berkeley, California, which had been computed by his now-celebrated "Short Method" by two of his pupils, Messrs. Haynes and Pitman, but again a long search by myself was fruitless. But, as usual, our good colleagues at Greenwich and Heidelberg had not been idle. They had also photographed the regions where MT might reasonably be expected to be found, and the new ephemerides led to renewed searches. On June 13 we received a letter from Dr. Crommelin stating that 1911 MT had been found on Greenwich plate of October 11, and he gave us a corrected ephemeris. The result was that a search was successful, and yielded a position for October 18. And by a later mail we learnt that Dr. Wolf also found the planet on one of his plates of October 17. I cannot do better than quote in *extenso* Dr. Crommelin's remarks in the *Observatory Journal*.†

"The interesting planet MT, discovered by Palisa last October and subsequently lost, has been unexpectedly resuscitated. The credit of this is due to Messrs. Haynes and Pitman, of Berkeley, California, and also to Professor Franz, of Breslau. These gentlemen computed orbits from the observations by Palisa on October 3 and 4, and that by Pechule later on October 4. It is highly to the credit of Leuschner's method that such accurate orbits were deduced from such a very short arc, particularly as it was near opposition, a region where the equations tend to become indeterminate. The ephemerides deduced from these orbits induced astronomers to re-examine their plates., with the result that three undoubted images were discovered by Mr. Davidson on Greenwich plates taken on October 11, and a streak of the right length and direction was found by Herr Ernst on a plate taken at Konigstuhl, Heidelberg, by Herr Kaiser on October 17. As this is in fair accord with the Greenwich position on October 11, there is little doubt that it is correct, and there is hope that still further images may be found.

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* *Monthly Notices*, February, 1912, p. 298.

† June, 1912, pp. 243-4.

"The planet has the same perihelion distance as that of Eros, 1.15, but an orbit of nearly double the eccentricity, the period being 2.6 years. The following orbit has been approximately corrected by the observations of October 11, and is pretty near the truth:

T	August, 1911. 31.4 G.M.T.	
ω	154° 1′	
Ω	185° 24′	1911.0
i	8° 32′	
log a	0.2756	
log e	9.5903	
Period	2.5907 years	

"The planet was nearest to the Earth early in September, when it was of the 11th magnitude. The following ephemeris has been computed in the hope that images may be found on plates taken at that time. It is for Greenwich midnight:—

	R.A.	Dec.	Log. r	Log. Δ
1911, October 3	$0^h\ 41^m\ 56^s$	0° 19′ N	0.0784	9.2894
4	0 43 52	0 16S	0.0793	9.3033
11	0 55 45	3 40	0.0868	9.3552
17	1 4 0	5 47	0.0939	9.4030
25	1 12 47	7 33	0.1043	9.4694
26	1 13 46	7 44S	0.1057	9.4777

"The places for the last three dates have been approximately corrected by the Heidelberg observation of October 17.

"It will be noticed that the planet remained practically in opposition to the Sun for two months. The next opposition will be about March, 1913, when the planet's magnitude will be 17 or 18. Most of its oppositions will take place in the neighbourhood of aphelion, as it hurries over the nearer part of its orbit and lingers in the further part."

It will be seen that the predicted place for

$$\text{October } 17 \quad 1^h\ 4^m\ 0^s - 5°\ 47'$$

is in sufficient agreement with our place for

$$\text{October } 18 \quad 1^h\ 4^m\ 14^s - 5°\ 59'.7$$

when allowance is made for the daily motion of about

$$65^s - 13'$$

Note added 1912 *November* 22.

Since the above was written two images of the planet MT were found on plates taken at Dr. Wolf's Observatory at Heidelberg on September 16, 1911, that is, 17 days before the planet was found by Privy Councillor Palisa, and a doubtful image was measured by Mr. Wood on his plate of 16th October. Omitting the latter, Herr Ludwig von Tolnay, a member of the Hungarian Parliament, has found an orbit which represents the observed places of the planet within 0.44 second of time in right ascension and 10 seconds of arc in declination. The latest observation is that made at the Union Observatory, and it is represented in the sense observation minus calculation as follows:—

R.A. —0.38 sec. Dec. — 1.4″

From Herr v. Tolnay's calculations we find that MT was in opposition on October 8, 1911, that its orbit is inclined to the Earth's at an angle of 10° 50′, that its angle of eccentricity is 32° 43′, and its mean distance from the Sun 2.58, and that, in

1911, it approached the Earth with 0.203 of the mean distance of the Sun. As the planet was in perihelion at the end of August and opposition took place in October, it is evident that, although the opposition was a favourable one, it was not the most favourable which can occur. Its period is 4.157 years, so that every 29 years it and the Earth come into the same relative position.

Sir David Gill.—It is announced in a recent number of *Science* that Sir David Gill has been elected the first honorary member of the Astronomical and Astrophysical Society of America.

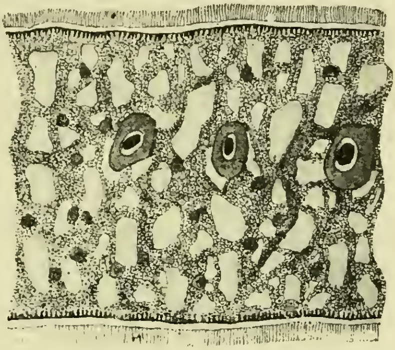
Irrigation by Sun-power in North Africa.—Details have recently been given of a pumping plant on the banks of the Nile in which the direct rays of the sun constitute the motive power. Five parabolic reflectors are mounted on steel frames 204 feet long, 20 feet apart, and having an area of 13,500 square feet. These reflectors are kept in a constant position relative to the sun by a thermostat. The solar rays are concentrated on a central boiler so as to raise steam at 100 lb. pressure, driving pumps delivering 6,000 gallons per minute with a 30 feet lift. The initial cost of the plant is £4,000, and the annual expenses £750. A steam plant of equal power would cost £2,000, with annual charges of £550, excluding fuel.

A Percentage Compass Dial.—Mr. J. G. Fergusson's percentage unit of angular measurement is claimed to provide an easy method of finding the ratio between base and hypotenuse, or between base and perpendicular, and to effect an immense saving in all angular computations as well as a considerable simplification of field calculations. Mr. Fergusson has made a practical application of his system to the magnetic compass dial, whereby the latter is declared to be converted into a simple and accurate range finder. The compass dial proper has an outer circle divided in percentages, and an inner circle divided in degrees, so that the compass may be read at a glance in both percentage units and degree units. Surrounding the floating compass card, and independent of it, is a circular scale of Natural percentage cosines, for the purpose of facilitating calculations. By the aid of this outer circle it is asserted that any problem in plane trigonometry may be solved by simple arithmetic. Amongst other advantages claimed for this compass card it is stated that the calculations of navigators, surveyors, and travellers may thereby be reduced to a minimum, and they are enabled to find at once, as they go along, (1) the difference of latitude and departure, (2) the closure angle of a compound traverse, and (3) the length of the closure line. The compass card is procurable, either mounted or unmounted, from Messrs. Longmans, Green & Co., London.

SOME OBSERVATIONS ON *CONVOLUTA ROSCOFFENSIS*.

By Horace Athelstan Wager, A.R.C.S.

Convoluta roscoffensis is a small marine worm of the Turbellarian group—a green plant animal as described by Professor Keeble in his little book on Plant-Animals. Hitherto it has, I believe, been recorded only from Europe, but both Dr. Warren and I have found it on the Natal coast. This species appears to be somewhat different from the European one as described by Professor Keeble, and is probably a degenerate form. It lives gregariously actually in the water, forming a dark olive-green scum on the sandy edge of small rocky pools just below high-water mark. It occurs at Umkomaas on a small stretch of about



20 yds., but not anywhere else in the vicinity of Umkomaas, although many places just as suitable, apparently, are quite frequent. This is rather surprising, as their beds are swept twice a day by the sea and the dissemination should be easy. The European species is found on moist patches of sand between tide marks, but not usually actually in the water. It is also very sensitive to vibration—an approaching footstep or an incoming wave causing nearly all of them to disappear below the surface of the sand. The Natal species, however, does not appear to be at all sensitive to vibration. They do not disappear when approached or even when subjected to greater vibration. The first tidal water that reaches them swills them all out of the pool and scatters them over the sand, and they then disappear below the sand. They are very delicate animals, as I found great difficulty in carrying them alive for any distance unless in a relatively large amount of sea-water. Also, they quickly die in an uncovered vessel of sea-water, probably owing to concentration of the water from evaporation, as the occasional addition of a little fresh water keeps them alive.

The structure of the animal appears to be rather more simple than in the European species. They have a very graceful gliding motion, but with a good deal of euglenoid movement. There is a mouth and gullet, but no alimentary canal. The whole animal is covered with very closely-set cilia. A thin epidermal layer is present which in section shows peculiar peg-like projections internally. These projections are evidently connected with a cross-set system of striæ on the outside of the animal which can be seen in tangential sections. These projections are, apparently, structureless and probably represent degenerate muscle fibres. In any case the striæ are probably connected with the retractivity of the animal, as in retracted specimens the projections appear much thicker. The main body of the animal appears to be composed of very minute celled parenchyma with many spaces. Amongst these cells are a few larger cells each with a big pyrenoid. These are probably the algal cells of Prof. Keeble, which in the European species are in greater number and arranged in longitudinal rows, and to which the green colour of the animal is due. In the Natal species the green colour is distributed throughout the small-celled parenchyma, together with a large number of darker green bodies, which may be either degenerate algal cells or free chlorophyll grains. The small cells have a stainable body in them but whether it is a nucleus or pyrenoid I have been unable to decide. In fact in microtome sections I have been unable to get any nuclear staining at all. The small cells are about 5 microns in size, the green grains from 5 to 10 microns, and the large pyrenoid cells are from 25 to 30 microns. I never found any evidence of the animal taking in any solid food particles.

The reproduction is the most peculiar feature of the animal. After repeated observations I could find no signs of any sexual organs either in the living animal or in microtome sections. Whether sexual reproduction has been discarded altogether it is, of course, difficult to say, but in any case there is a prolific means of asexual reproduction which, I believe, has not previously been recorded, that is, by the severance of parts of the animal, each part being able to form itself into a new animal. This severance may be due to accident such as being dashed against the sand, stones, etc., in which case the delicate animal comes off badly, but even the smallest pieces appear able to regenerate. I have divided a single animal into four parts, and after about two hours each part had assumed the elongate ribbon shape of a mature animal, swimming about the whole time. This method of reproduction by the regeneration of parts is of course well known in many animals, such as *Hydra*, but it is only resorted to in case of accident. The animals concerned cannot be said to reproduce by this method. In the case of *Convoluta*, however, the delicate nature of the animal is one of its peculiar features, the slightest touch causing it to break or become damaged. In many cases the animal actually puts out protuberances which gradually elongate, and then become separate. This process takes only a short time—about an hour to complete, so that this is hardly a case of budding in so far as the protrusions are not formed by growth.

I hardly think that the features here described are sufficient to characterise the animal as a new species. It is probably a degenerate form or a variety of the European species.

The figure is that of a longitudinal section of the animal and shows the small-celled parenchyma, the peg-like projections, pyrenoid cells and some green grains.

SIR W. H. WHITE.—By the sudden death, on the 27th February, of Sir William Henry White, K.C.B., Sc.D., LL.D., D.Eng., F.R.S., one of the most noted naval architects and engineers of our time has passed from the scene. Only a few months ago Sir William had been elected President of the British Association for the Advancement of Science, and he was to have presided over the next Annual Session of that Association, which is appointed to take place in Birmingham during September. Born in February, 1845, White entered the Royal Dockyard at Devonport as an apprentice at the age of fourteen, and five years later he was the first student to be enrolled in the Royal School of Naval Architecture at South Kensington. In 1870 Mr. White joined the Constructive Department of the Admiralty, in which he had risen to the position of Chief Constructor at the time when he left the Department in order to associate himself with the great engineering firm of W. G. Armstrong & Co. During this period of his connection with the Admiralty (1870-1883), White had taken a prominent part in the new designs, whereof H.M.S. *Inflexible,* with her two turrets *en échelon*, each provided with two 16 in. (81 ton) guns, was the embodiment. Sir Edward Reed, who had retired from the post of Chief Constructor to the Navy in 1870, led a strong opposition against these designs, but a specially qualified committee was appointed to report on them, and, after long and exhaustive practical trials, this committee reported that the design fully satisfied all that the conditions expected of it. The *Inflexible*, which was the first ship in the British Navy to carry compound armour, took a prominent part in the bombardment of Alexandria (1882), and was then the most recent ironclad in the fleet. Subsequent developments of this design were represented by H.M.SS. *Ajax*, *Agamemnon, Colossus*, and *Edinburgh*, and in the construction of the hulls of the last two battleships Sir William first superseded iron by steel. In 1885, the Director of Naval Construction, Sir Nathaniel Barnaby, having resigned, White rejoined the Admiralty as his successor, and remained Director until 1902. The *Lusitania* and *Mauretania* were amongst the steamships with whose design and construction he was associated in later years. Sir William White presided over the Royal Society of Arts in 1908 and 1909. In 1903 he was President of the Institution of Civil Engineers. Of the Institution of Mechanical Engineers he had also been President. In 1877 he first joined the Council of the Institution of Naval Architects, becoming Vice-President in 1886. He was also connected with the Imperial College of Science and Technology, and with the National Physical Laboratory.

CAPE WINE-LEVURES AND THEIR USE IN WINE-MAKING: A PRELIMINARY STUDY.

By Abraham I. Perold, B.A., Ph.D.

Introduction.

As far as I know this is the first inquiry into the question of pure wine-levures cultivated at the Cape.

In the past the vinous fermentation was sometimes controlled at the Cape by using potassium meta-bisulphite, whereby the micro-flora of the must was favourably influenced from the œnological point of view. The addition of sulphites serves a double puprose. It not only effects a partial selection of levures, inasmuch as the wine-levures or elliptic levures, *Saccharomyces ellipsoideus*, are much less checked by sulphur dioxide in their development than the remaining micro-flora of the must, but it further hinders the fermentation to a certain extent (a sufficiently high dosis of it will prevent any fermentation at all), so that less heat is developed in the same increment of time, in other words it helps in keeping down the temperature of fermentation to a certain extent. Since this is of primary importance in wine-making, it follows clearly that a reasonable addition of sulphites to must is most useful and may become almost imperative in certain cases.

In certain isolated cases imported French or German levures were used. During the last couple of vintages some of the levures that will be discussed in this paper have been used by various parties with good results in all cases. They will no doubt be used much more largely in future.

At this stage it may be useful briefly to point out the *use of pure levures in wine-making*. As is well-known to most people, ripe grapes, when crushed, start fermenting spontaneously. Through the studies of Pasteur and others it was proved that on the skins of the ripe berries are to be found the levures and some of the other micro-organisms that are later on present in the fermenting must. If the berries had been wounded some time before they were picked, they will nearly always contain acetic bacteria, which are a source of danger to the wine. In case the crushed grapes are exposed to the air for some days (for instance, during a spell of cold weather) without any proper fermentation having set in, they likewise offer favourable conditions for the development of acetic bacteria. In such cases the dops and must are liable to get sour before the vinous fermentation has properly set in. Since in this mixed micro-flora there are many harmful and dangerous species, such as the *acetic* and *mannitic* bacteria (both specially to be feared in hot climates), further bad levures such as the *Saccharomyces apiculatus*, which unfavourably influences the organoleptic properties of the wine and cannot carry the fermentation beyond about 5.6 volume per cent. of alcohol, and bad elliptic levures—

as will be seen later on—it will be easily understood that an adequate addition of pure levures to the fresh must is of necessity most useful. The addition of a large quantity of pure levures to the fresh must enables the particular levure to multiply itself to such an extent as to suppress the other micro-organisms effectively by its vastly superior numbers. So that, although the must is not sterilised, it is still possible for the pure levures to bring out their characteristic properties in the product of fermentation, namely, the wine.

The main advantages gained by conducting a fermentation with pure levures are:

(1) An almost immediate fermentation whereby the dops and must are prevented from getting sour before the vinous fermentation starts.

(2) A *regular fermentation* until either all the sugar has disappeared or so much alcohol has been formed (16-17 volume per cent.), that it prevents any further fermentation. This is one of the main points in favour of using pure levures.

(3) *A firm depôt of lees*, the wine thus getting bright fairly soon.

(4) *A clean taste*, which is very important.

(5) A slight influence on the *bouquet* of the wine, although this must not be exaggerated. In order to sell their pure levures, say, from Johannisberg or the Champagne district or Sauternes, some unscrupulous people maintain on their advertisements that it is possible to make, say, a Sauternes wine out of any ordinary must by using their Sauternes levures. This, of course, is nonsense. It is, to say the least of it, a gross exaggeration of the truth.

(6) Must fermenting with good pure levures can go up to such *high temperatures* as 38 to 40° C. without running much risk of being subjected to mannitic fermentation, for the simple reason that the levures have all along been so active and predominant that the mannitic bacteria had no chance of developing, and are consequently practically wanting in such a must. The results obtained with my pure levures during several vintages go to prove the accuracy of the above.

It may be here pointed out that, if the temperature goes up to 38-40° C. in a *spontaneous* vinous fermentation, a *mannitic fermentation* easily sets in, since the levures usually have to struggle for existence at such a high temperature, whereas the mannitic bacteria find no difficulty in propagating themselves under these circumstances. Since the mannitic bacteria form mannite out of the sugar of the must together with certain unpleasant volatile acids, a wine that has suffered from a mannitic fermentation remains sweetish-sour (*aigre-doux*) and has an unpleasant taste characteristic of the disease. Since the sweetness is here due to mannite, it cannot be made to disappear by a subsequent inoculation with pure levures, because mannite is unfermentable by levures.

1. Selection and Cultivation of the Pure Levures.

The levures PA1-4, HeA1-4, GA1-2 were obtained by bringing some fresh Pontac. Hermitage and Greengrape lees from Mr. G. A. Retief's farm at Paarl into some sterilised must, taking the fresh lees formed by this last fermentation and pouring must-gelatine plates in the usual way. Some well isolated and simple colonies were inoculated into sterile must in test-tubes taking the usual precautions. So as to make quite sure that the cultures were really pure, that is, contained only descendants from one original cell, plates were once more poured of these cultures. They always gave the same colonies showing their purity. One of these colonies was then inoculated into sterilised must as before, and constituted the pure culture worked with. Since several colonies were originally inoculated into sterilised must, there are up to four cultures from one kind of lees. Thus PA1, PA2, PA3, PA4 are four cultures from Pontac lees. Since these studies are still incomplete it is at present impossible to say much about the identity of the different cultures. Still, it is certain that several of them are the same.

In the same way as above, PB1-2, GB1-3, and HaB1-3 were obtained from the lees of the second crop grapes of Pontac. Greengrape and Hanepoot at the Oenological Station, Paarl. HaC1-3 were similarly obtained from a Hanepoot wine sent in for examination, and that had suffered from a mannitic fermentation. These cultures were made during 1910 and have been used in wine-making during the 1911 and 1912 vintages.

2. Fermentation Experiments with these Pure Cultures.

For these fermentations a sterilised, filtered must was used, whose sugar was 25.8° Balling, and total acidity equal to 4.01 per mille Tartaric acid. Of this must 400 ccm. was introduced into 500 ccm. bottles, which were plugged with cotton-wool and then sterilised in steam in the usual way. In a Hansen sterile case streak-cultures on must-gelatine of the various selected cultures all of the same age were taken to inoculate the different flasks, taking the necessary precautions to avoid foreign infections. In the Hansen case and immediately after inoculation, the cotton wool plugs were replaced by sterilised, perforated corks containing fermentation-tubes into which had been poured some dilute sulphuric acid to act as an air-valve and exclude any ulterior infection. The charged, inoculated bottles were then weighed and placed in a thermostat, which was at 23-25° C., weighed daily at the same hour and again put into the thermostat.

The bottles were inoculated between 11 and 12 a.m. on the 7th November, 1910.

At 9.30 p.m. on the 8th November the following were visibly fermenting: HaB1, HaB2, HaB3, GB2, GB3, anl PB1.

At 8 a.m. on the 9th November the following were also fermenting: HeA1, HeA2, HeA3, HeA4, PB2 (weak), GB1 and HaC3.

At 11.30 a.m. on the same day also PA1, PA3 and PA4.

HaC1 and HaC2 had thin films covering the whole surface. They were *mycoderma vini* or flowers of wine and not levures, and never showed any sign of fermentation.

On the 10th November also PA2 was fermenting, whilst GA1 and GA2 showed a good *mycoderma* layer mounting along the sides of the bottles.

On the 12th November GA1 and GA2 had built a fair amount of foam and were fermenting slowly. The *mycoderma* layer had been broken by the escaping gas.

The following tables give the weights of the different flasks that were found at each day's weighing. HaC1 and HaC2 never lost anything in weight.

From these results it follows, that the first six cultures, PA1-4 and GA1-2 can hardly be considered as wine-levures at all. In any case they are worthless from the œnological point of view. GA1 and GA2 developed fairly thick mycodermic layers. Their exact nature will be studied later on. HaC1 and HaC2 were some species of *Mycoderma vini* and had no fermentative power at all. The remaining thirteen cultures showed themselves to be proper wine-levures. Further, with the exception of HeA1 and GB1 (which were not quite so active as the others), they proved to be very active levures with a high fermenting power.

The best no doubt are the following:—

HeA2, HeA3, HeA4, PB1, GB2, GB3, HaB1, HaB2, HaB3 and HaC3.

The attached fermentation curves of some of the cultures show distinctly three types of levures:

(*a*) weak ones: PA1 (also PA2,3,4) and GA2 (also GA1).

(*b*) medium ones: GB1 (also HeA1).

(*c*) strong ones: HeA3, PB2, HaB3, HaC3, and the rest.

On further examining these curves we find:

(1) That after 48 hours four cultures had already suffered considerable loss in weight. The others had not yet lost anything. The reason why such a strong ferment as PB2 should lag thus behind the others, is probably to be sought in a relatively small number of its cells being introduced into the must at the time of inoculation.

(2) The maximum daily loss (with exception of the two weak levures, PA1 and GA2) takes place in each case between 48-72 hours after inoculation.

Culture.	7th Nov	Diff	9th Nov	Diff	10th Nov	Diff	11th Nov.	Diff	12th Nov.	Diff	13th Nov.	Diff	14th Nov.	Diff	15th Nov.	Diff	16th Nov.	Diff	17th Nov.	Diff	18th Nov.	Dff	19th Nov.	Diff	20th Nov.	Diff	21st Nov.
PA1	895	0	895	0	895	1·7	893·3	0·8	892·5	0·9	891·6	0·5	891·1	0·8	890·3	0·6	889·7	0·5	889·2	0·5	888·7	0·6	888·1	0·4	887·7	0·1	887·6
PA2	896	0	896	0	896	0·9	895·1	0·7	894·4	0·8	893·6	0·4	893·2	0·9	892·3	0·6	891·7	0·7	891·0	0·8	890·2	0·7	889·5	0·6	888·9	0·3	888·6
PA3	882	0	882	2	880	2·1	877·9	1·3	876·6	1·1	875·5	1·0	874·5	1·0	873·5	0·7	872·8	0·9	871·9	0·7	871·2	0·6	870·6	0·5	870·1	0·2	869·9
PA4	814	0	814	1	813	1·9	811·1	1·1	810·0	0·8	809·2	0·8	808·4	0·8	807·6	0·7	806·9	0·5	806·4	0·5	805·9	0·4	805·5	0·3	805·2	0·1	805 1
GA1	813	0	813	0	813	0·9	812·1	0·6	811·5	0·4	811·1	0·5	810·6	0·6	810·0	0·7	809·3	0·5	808·8	0·7	808·1	0·6	807·5	0·6	806·9	0·3	806·6
GA2	920	0	920	0	920	0·8	919·2	0·7	918·5	0·5	918·0	0·4	917·6	1·0	916·6	0·6	916·0	0·6	915·4	0·6	914·8	0·7	914·1	0·5	913·6	0·4	913·2
HeA1	893	0	893	4	889	3·3	885·7	2·6	883·1	2·9	880·2	2·6	877·6	2·6	875·0	2·3	872·7	2·2	870·5	2·2	868·3	1·5	866·8	0·7	865 1	0·9	864·2
HeA2	892	4	888	10	878	9·4	868·6	5·8	862·8	4·4	858·4	3·3	855·1	2·4	852·7	1·5	851·2	1·4	849·8	1·1	848·7	0·7	848·0	0·6	847·4	0·3	847·1
HeA3	833	3	830	10	820	8·0	812·0	5·8	806·2	4·3	801·9	3·8	798·1	2·8	795·3	1·8	793·5	1·7	791·8	1·4	790·4	0·9	789·5	0·8	788·7	0·4	788·3
HeA4	842	2	840	10	830	7·6	822·4	5·7	816·7	4·2	812·5	3·7	808·8	2·7	806·1	2·0	804·1	1·7	802·4	1·5	800·9	1.0	799·9	0·9	799·0	0·4	798·6
PB1	878	5	873	10	863	5·9	857·1	4·3	852·8	3·2	849·6	2·3	847·3	2·0	845·3	1·5	843·8	1·3	842·5	1·2	841 3	1·0	840·3	0·8	839·5	0·4	839·1
PB2	834	0	834	12	822	9·8	812·2	5·1	807·1	3·7	803·4	2·7	800·7	2·3	798 4	1·8	796·6	1·4	795·2	1·4	793·8	1·0	792·8	0·8	792·0	0·5	791·5
GB1	895	2	893	7	886	5·4	880·6	3·2	877·4	2·8	874·6	2·3	872 3	2·1	870·2	1·5	868·7	1·3	867·4	1·3	866·1	1·1	865·0	0·9	864·1	0·4	863·7
GB2	813	6	807	10	797	6·0	791·0	3·7	787·3	2·9	784·4	2·2	782·2	1·9	780·3	1·5	778·8	1·3	777·5	1·3	776·2	1·1	775·1	0·8	774·3	0·4	773·9
GB3	876	7	869	12	857	6·4	850·6	3·7	846·9	3·2	843·7	2·3	841·4	2·1.	839·3	1·5	837·8	1·3	836·5	1·2	835·3	1·0	834·3	0·8	833·5	0·5	833·0
HaB1	880	8	872	12	860	6·6	853·4	3·6	849·8	2·8	847·0	1·8	845·2	1·7	843·5	1·4	842·1	1·0	841·1	1·1	840·0	0·8	839·2	0·7	838·5	0·4	838·1
HaB2	813	7	806	11	795	6·1	788·9	3·8	785·1	2·9	782·2	2·2	780·0	1·8	778·2	1·2	777·0	1·2	775·8	1·0	774·8	0·9	773·9	0·8	773·1	0·5	772·6
HaB3	838	6	832	12	820	6·6	813·4	4·0	809·4	3·2	806·2	2·5	803·7	2·1	801·6	1·7	799·9	1·4	798·5	1·4	797·1	1·0	796·1	0·9	795·2	0·5	794·7
HaC3	810	2	808	11	797	9·1	787·9	6 7	781·2	5·2	776·0	3·9	772·1	2·6	769·5	1·7	767·8	1·2	766·6	1·1	765·5	0·7	764·8	0·4	764·4	0·2	764·2

Culture.	Diff	22nd Nov.	Diff	23rd Nov.	Diff	24th Nov.	Diff	25th Nov.	Diff	26th Nov.	Diff	27th Nov.	Diff	1st Dec.	Diff	2nd Dec.	Diff	6th Dec.	Diff	14th Dec.	Diff	22nd Dec.	Total Loss.
PA1	0·2	887·4	0·3	887·1	0·1	887·0	0·1	886·9	0·1	886·8	0·2	886·6	0·2	886·4	0·1	886·3	0·1	886·2	0·0	886·2	0·5	885·7	9·3
PA2	0·4	888·2	0·8	887·4	0·0	887·4	0·3	887·1	0·3	886·8	0·3	886·5	0·9	885·6	0·2	885·4	0·5	884·9	3·1	881·8	3·0	878·8	17·2
PA3	0·1	869·8	0·2	869·6	0·1	869·5	0·0	869·5	0·1	869·4	0·1	869·3	0·1	869·3	0·0	869·3	0·0	869·3	0·2	869·1	0·2	868·9	13·1
PA4	0·2	804·9	0·1	804·8	0·1	804·7	0·0	804·7	0·1	804·6	0·1	804·5	0·0	804·5	0·0	804·5	0·0	804·5	0·0	804·5	0·1	804·4	9·6
GA1	0·4	806·2	0·5	805·7	0·3	805·4	0·3	805·1	0·3	804 8	0·4	804·4	1·0	803·4	0.0	803·4	1·4	802·0	2·6	799·4	1·9	797·5	15·5
GA2	0·4	912·8	0·5	912·3	0·3	912·0	0·4	911·6	0·3	911·3	0·4	910·9	1·0	909·9	0·4	909·5	1·5	908·0	3·4	905·4	2·9	902·5	17·5
HeA1	0·9	863·3	0·7	862·6	0·6	862·0	0·5	861·5	0·6	860·9	0·5	860·4	1·3	859·1	0·3	858·8	0·8	858·0	1·2	856·8	0·6	856.2	36·8
HeA2	0·3	846·8	0·3	846·5	0·2	846·3	0·2	846·1	0·1	846·0	0·2	845·8	0·3	845·5	0·1	845 4	0·3	845·1	0·6	844·5	0·6	843·9	48·1
HeA3	0·4	787·9	0·3	787·6	0·2	787·4	0·2	787·2	0·2	787·0	0·2	786·8	0·2	786·6	0·1	786·5	0·3	786·2	0·6	785·6	0·4	785·2	47·8
HeA4	0·6	798·0	0·3	797·7	0·3	797·4	0·3	797·1	0·3	796·8	0·2	796·6	0·5	796·1	0·1	796·0	0·4	795·6	0·6	795·0	0·5	794·5	47·5
PB1	0·6	838·5	0·4	838·1	0·3	837·8	0·4	837·4	0·2	837·2	0·4	836·8	0·3	836·5	0·4	836·1	0·7	835·4	0·9	834·5	0·7	833·8	44·2
PB2	0·5	791·0	0·5	790 5	0·3	790·2	0·4	789·8	0·3	789·5	0·3	789·2	0·2	789·0	0·6	788·4	0·6	787·8	1·0	786·8	0·6	786·2	47·8
GB1	0·6	863·1	0·7	862·4	0·4	862·0	0·4	861·6	0·4	861·2	0·4	860·8	0·8	860·0	0·3	859·7	0·7	859·0	1·2	857·8	0·7	857·1	37·9
GB2	0·5	773·4	0·6	772·8	0·4	772·4	0·3	772·1	0·4	771·7	0·3	771·4	0·7	770·7	0·5	770·2	0·4	769·8	2·0	767·8	1·0	766·8	46·2
GB3	0·5	832·5	0·6	831·9	0·3	831·6	0·4	831·2	0·3	830·9	0·4	830·5	0·5	830·0	0·3	829·7	0·7	829·0	0·7	828·3	0·6	827·7	48·3
HaB1	0.4	837·7	0·4	837·3	0.3	837·0	0·3	836·7	0·3	836·4	0·4	836·0	0·4	835·6	0·3	835·3	0·3	835·0	1·3	833·7	0·8	832·9	47·1
HaB2	0·4	772·2	0·6	771·6	0·3	771·3	0·4	770·9	0·3	770·6	0·4	770·2	0·6	769·6	0·4	769·2	0·9	768·3	1·1	767·2	1·1	766·1	46·9
HaB3	0.5	794·2	0·6	793·6	0·4	793·2	0·3	792·9	0·4	792·5	0·3	792·2	0·4	791·8	0·4	791·4	0·6	790·8	0·8	790·0	0·5	789·5	48·5
HaC3	0·3	763·9	0·2	763·7	0·1	763·6	0·1	763·5	0·1	763·4	0·2	763·2	0·0	763·2	0·0	763·2	0·2	763·0	0·3	762·7	0·2	762·5	47·5

In case of GB1 this amounts to 18.5% of its total loss.
" " " HeA3 " " " 20.9% " " " "
" " " HaC3 " " " 23.2% " " " "
" " " HaB3 " " " 24.7% " " " "
" " " PB2 " " " 25.1% " " " "

(3) The main fermentation takes place during the first eight or nine days. This is evident from the curves, and is further proved by the following table:—

Culture.	Loss after 5 days.	Loss after 9 days.
PA1	2·5 grs.=26·9% of total loss	5·3 grs.=57·0% of total loss
GA2	1·5 " =8·6 " " "	4·0 " =22·9 " " "
HeA3	26·8 " =56·1 " " "	39·5 " =82·6 " " "
PB2	26·9 " =56·3 " " "	37·4 " =78·2 " " "
GB1	17·6 " =46·4 " " "	26·3 " =69·4 " " "
HaB3	28·6 " =59·0 " " "	38·1 " =78·5 " " "
HaC3	28·8 " =60·6 " " "	42·2 " =88·8 " " "

Since the fermentation has in most cases set in only 36-48 hours after inoculation, we see from the above, that the best and most active levures, HeA3, PB2, HaB3 and HaC3, cause 56-60% of the total loss during a fermentation of about 3-3½ days, and 78-89% of the total loss during a fermentation of about seven days.

3. Analytical Results.

During the first week in January, 1911, the contents of the various flasks were analysed for alcohol.

In the following table are given the results of these analyses, which were all done in duplicate, the results agreeing very closely. For the sake of comparison the amounts of alcohol (by volume) that should have been formed according to the equation $C_6H_{12}O_6 = 2CO_2 + 2CH_6O$, have been calculated out of the loss of 100 ccm. contents of the flasks, *i.e.*, $\frac{1}{4}$ of the total loss, since the flasks all contained 400 ccm. must, and the calculated values placed opposite those found by analysis.

It will be observed that in case of PA3, PA4 and GA1 the alcohol was not determined, since they are of no importance as pure levures, and half of this class had been analysed.

From the table on the next page we see:

(1) That of the 13 proper wine-levures only HeA1, PB1 and GB1 have formed under 15 volume per cent. alcohol. The remaining 10 formed from 15.70-16.37 *volume per cent.*

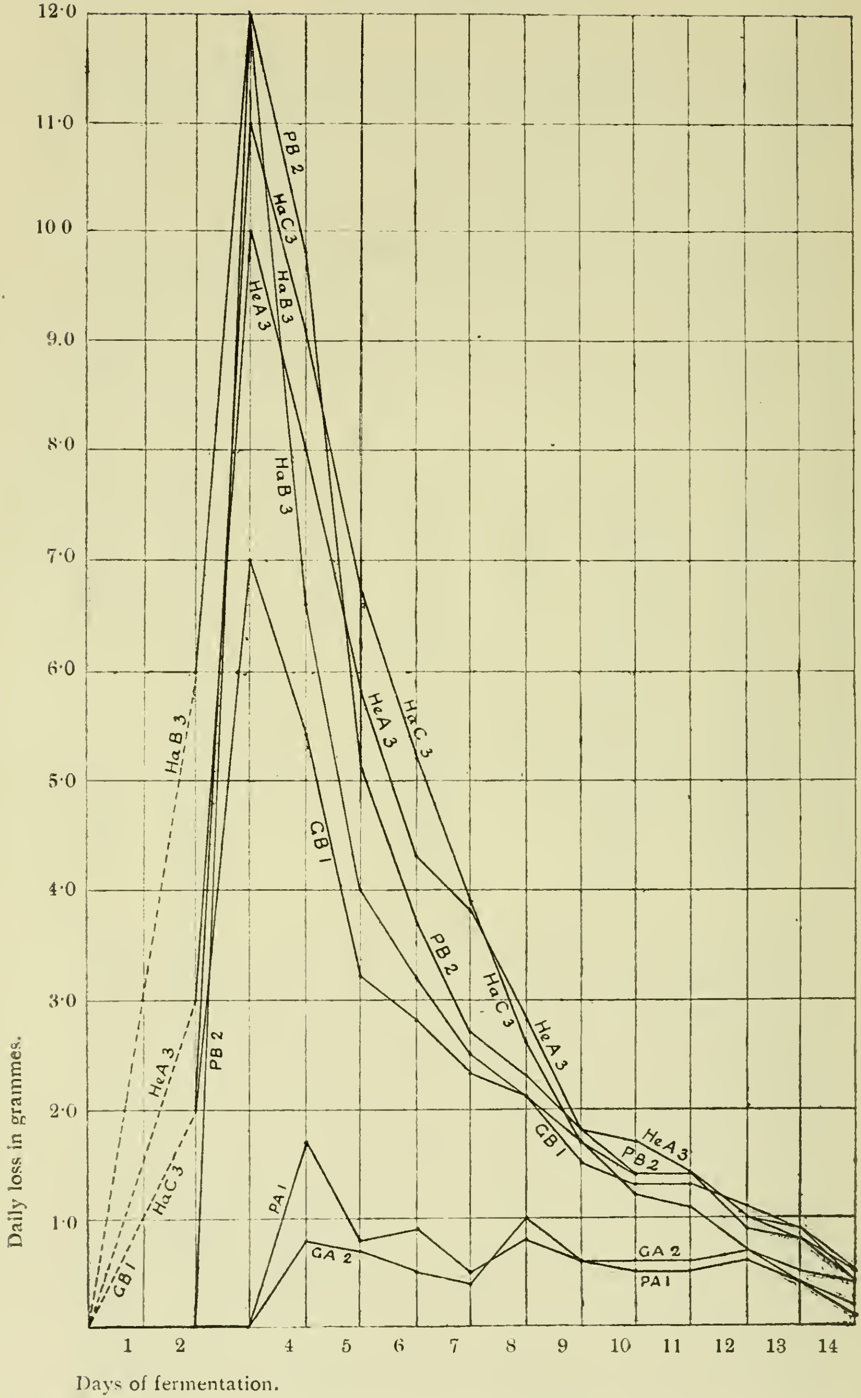
which is *very high indeed.* It must be borne in mind that most œnologists in Europe are of opinion that wines with over 15 volume per cent. alcohol are fortified, since they maintain that a natural wine cannot have over 15 volume per cent. alcohol. In fact the Swiss law on the importation of wines regards all wines of above 15 volume per cent. alcohol as fortified.

From my cellar experiments with these levures it will be seen that they can on a large scale form wines of over 15 volume per cent. alcohol, which are absolutely natural and unfortified.

(2) That the calculated alcohol-values, in case of the 13 proper wine-levures and with the exception of HeA1, PB1 and

Culture.	Alcohol found.	Alcohol Calculated	Difference.
PA1	3·37 Vol. %	3·01 Vol. %	0 36 Vol. %
PA2	6·85 ,, ,,	5 62 ,, ,,	1·23 ,, ,,
GA2	6 52 ,, ,,	5·72 ,, ,,	0 80 ,, ,,
HeA1	14·97 ,, ,,	12·02 ,, ,,	2 95 ,, ,,
HeA2	16·19 ,, ,,	15·71 ,, ,,	0 48 ,, ,,
HeA3	16 14 ,, ,,	15 62 ,, ,,	0·54 ,, ,,
HeA4	16 04 ,, ,,	15·52 ,, ,,	0·52 ,, ,,
PB1	14·29 ,, ,,	14·44 ,, ,,	—0 15 ,, ,,
PB2	16·37 ,, ,,	15·62 ,, ,,	0 75 ,, ,,
GB1	14·92 ,, ,,	12·38 ,, ,,	2·54 ,, ,,
GB2	15 70 ,, ,,	15·08 ,, ,,	0·62 ,, ,,
GB3	16 25 ,, ,,	15·78 ,, ,,	0·42 ,, ,,
HaB1	15·85 ,, ,,	15·39 ,, ,,	0 46 ,, ,,
HaB2	15·77 ,, ,,	15 32 ,, ,,	0 45 ,, ,,
HaB3	16·13 ,, ,,	15·85 ,, ,,	0 28 ,, ,,
HaC3	15·89 ,, ,,	15·52 ,, ,,	0·37 ,, ,,

GB1, which formed under 15 volume per cent. alcohol, differ from the actually found values by 0.49 volume per cent. alcohol (on an average). Since some of the carbon dioxide formed by fermentation is dissolved in the wine and has replaced the air in the flask, it must be expected, that the calculated value for the alcohol will be less than that found by analysis. Here it is assumed that the loss of each flask represents the weight of carbon dioxide formed by fermentation less that still in the flask, it being assumed that no other gas is evolved. This is quite a safe assumption to make, since the strong sulphuric acid in the fermentation tube will dry the gas as it escapes, so that no moisture will be lost, and since no other gas than carbon dioxide is known to be formed during the vinous fermentation, the dry carbon dioxide gas above the sulphuric acid in the fermentation tube and the way it is partly cut off from the air by its glass capsule will prevent any noticeable quantity of watervapour from the air being absorbed.



Fermentation Curves of the Cultures PA 1, GA 2, HeA 3, PB 2, GB 1, HaB 3, and HaC 3 during 14 days of fermentation.

If we now put the amount of carbon-dioxide formed by fermentation and still kept inside the flask dissolved in the wine and standing above it, at 1.5 grammes, then we should have to add $\frac{1{\cdot}5}{4} \times \frac{46}{44}$ grammes $= \frac{51{\cdot}}{4} \times \frac{46}{44} \times \frac{10}{8}$ ccm. $= 0{\cdot}49$ ccm. alcohol per 100 ccm. wine to the value calculated.

In other words, the average difference between the calculated and the actually found alcohol-values will be eliminated by assuming each flask to contain about 1.5 grammes of carbon dioxide formed by fermentation, which is quite a reasonable assumption. This point will be examined during my further research on this subject.

The above at any rate tends to show that the relative amounts of carbon dioxide and alcohol formed during a pure vinous fermentation are in accordance with the equation already quoted, namely,

$$C_6H_{12}O_6 = 2CO_2 + 2C_2H\ O$$

invert sugar = carbon dioxide + ethyl-alcohol

It is at present impossible to explain the three exceptions to the above, namely, HeA1, PB3 and GB1.

(4) Since the must used contained about 258 grammes sugar per litre, we see that the good wine-levures formed 10 ccm. alcohol out of $\frac{258}{163{\cdot}7} \times 10$ till $\frac{258}{157{\cdot}0} \times 10$ grs sugar (the wines had 15.70 - 16.37 volume per cent. alcohol) or 10 *volume per cent. alcohol in the wine was formed out of* 158-164 *grs. sugar per litre of must.* In Europe the reckoning is usually 10 volume per cent. or degrees of alcohol for 170 grs. sugar per litre of must. The figures obtained with these levures in cellar experiments will be given in the next part of this paper. According to the above equation 46 grs. or 57.5 ccm. alcohol are formed from 90 grs. sugar, hence 100 ccm. alcohol or 10 volume per cent. are formed from 156.5 grs. sugar.

In actual practice this figure is never quite reached, since the living levures form in addition to alcohol also several other products, such as glycerine, succinic acid, volatile acids, apart from the sugar which they consume as food. The amount to be allowed for this is usually about 5%, so that it is considered that the above fermentation holds good for about 95% of the total sugar in the must.

In the experiments here related the following percentages of total sugar were thus decomposed:

Let x be the percentage sought.

Then in case of the wine with 15.70 volume per cent. alcohol we have $\frac{x \times 258}{100}$ grs. sugar giving 157.0 ccm. alcohol.

Hence 100 ccm. alcohol were found out of $\frac{x \times 258}{157.0}$ grs. sugar.

But 100 ccm. alcohol are formed out of 156.5 grs. sugar if 100% of the sugar is decomposed.

$$\text{Hence } \frac{x \times 258}{157.0} = 156.5$$

whence $x = 94.8\%$.

In case of the wine with 16.37 volume per cent. alcohol this becomes 99.3%. Reckoning 170 grs. sugar per 10 volume per cent. alcohol means that only 92% sugar gave alcohol. This makes no allowance for alcohol lost by evaporation.

4. Cellar Experiments with these Levures.

1. Pontac. Vintage 1911.

Pressed on 8th February, 1911.

Composition of must: Sugar = 27.7° Balling.

Total acidity = 9.7% as Tartaric acid.

The crushed grapes minus their stalks were immediately inoculated with a pure culture of the levure PB2, the proportion being about 1.200 or ½%. Fermentation started very soon, since the must had a temperature of 26° C. atthe very start. During 48 hours the fermentation was conducted in an open cement tank, the cake that forms on the fermenting must being pressed under about every two hours. Then the must was drawn off into 4 hogsheads—the press-must being added to the rest. When the temperature had got to 35° C. in the hogsheads, 100 grs. of potassium metabisulphite was added to each of them. This so far checked the fermentation that the temperature did not rise above 35° C. On the 23rd February (15 days after the grapes had been crushed) the young wine was racked over into a stukvat (under 2 leaguers capacity). On the 15th March the wine was fairly bright, and just a little sweetish. It was then racked into hogsheads, where a slight fermentation set in, and the remaining sugar fermented out.

An analysis made on the 27th April, 1911, gave the following results:—

Alcohol = 15.34% by volume.

Total Acidity = 8.75 per mille as Tartaric acid.

Volatile acids = 0.75 per mille as Acetic acid.

The wine was again analysed about the 20th November, 1911, and then gave the following results:—

Specific Gravity at 15° C. ..	0.9982.
Alcohol..	15.7 volume per cent.
Extract	4.6 grs. per 100 ccm.
Ash	0.4820 grs. per 100 ccm.
Sugar	0.05 grs. per 100 ccm.
Total Acidity	7.95 per mille as Tartaric acid.
Volatile acids	0.85 per mille as Acetic acid.
Glycerine (on 22/11/11)	1.33 grs. per 100 ccm.
Alcohol: glycerine .. =	100:10.6.

The wine was perfectly dry, and had a very dark colour (red on dilution with water).

It must be noted:

(*a*) That during the open fermentation and at the high temperature (26-33° C.) prevailing, a fair amount of alcohol got lost by evaporation. Still, the young wine had 15.34 volume per cent. alcohol, and the wine, when 8½ months old had 15.7 volume per cent. alcohol. This is a case of a *natural, unfortified wine with over 15 volume per cent. alcohol.* In the following cases this will be found repeatedly.

(*b*) The total acidity is high. This is characteristic of the Pontac grape.

(*c*) The volatile acidity is rather high, although not too high for such a full-bodied, heavy wine. The high temperature of fermentation will account for this.

(*d*) The sugar has all been decomposed. The slight amount found (0.05gr. per 100 ccm. wine) is only half of the amount generally reckoned for the reducing substances other than sugar in a normal dry wine.

(*e*) The glycerine (determined by Stritar's isopropyl iodide method) is high, but on account of the high alcoholic strength of this wine, the alcohol-glycerine ratio of 10.6 still falls within the limits, 7-14, usually adopted for this ratio in pure natural wines.

2. WHITE FRENCH. Vintage 1911.

Pressed on 9th February, 1911.
Composition of must: Sugar = 21.6° Balling.
Total Acidity = 4.68 per mille as Tartaric acid.

The must was at once separated from the husks and stalks, the press-must being added to the rest. To increase the low acidity of the must, 2 lbs. of Tartaric acid were added to 1 leaguers must, or about 1 gramme Tartaric acid per litre must.

The must was at once started with a pure culture of GB3 the quantity added being about ½% of the must, and then fermented in a stukvat, closed with a fermenting bung.

Temperature: 27° C. at the start; when the temperature had gone up to 33° C., 300 grs. potassium metabisulphite was added which means about 160 mg. sulphur dioxide per litre must. This was on the 10th February, 1911. The maximum temperature of 38° C., or 100.4° F. (very high) was reached on the 11th February, 1911. Then it went down, and the fermentation continued regularly, till all the sugar had been decomposed.

On the 3rd March the young wine was fairly bright and quite dry. On the 21st March, 1911, a further addition of 2 lbs. Tartaric acid was made, since the wine was too flat in taste.

On the 3rd May the wine was analysed with the following results:—

Alcohol	11.35 volume per cent.
Total Acidity	5.9 per mille as Tartaric acid.
Volatile Acids	0.65 per mille as Acetic acid.

Notes.

(1) A great deal of alcohol was lost owing to the high temperature of fermentation, as is seen from the fact that about 190 grs. sugar per litre must were needed to form 10 volume per cent. alcohol.

(2) The volatile acidity is somewhat high for such a light wine. This is no doubt due to the *very high temperature* at which the fermentation took place. The wine is perfectly sound, and this shows that the *volatile acids were mostly formed by the wine-levures themselves*, and *not by acetic bacteria*. If such a light wine had undergone a spontaneous fermentation at so high a temperature, it would hardly have been sound, and would almost for certain have been higher in volatile acids. When it is unavoidable to have a high fermentation-temperature, the safest is to make use of good pure levures.

(3) This wine is now over 2 years old, and as sound as ever. It is perfectly bright, has a pale greenish colour, and on analysis on the 6th June, 1912, gave the following results:—

Alcohol: 11.65 volume per cent., an increase of 0.3 volume per cent. since 3rd May, 1911.

Volatile Acidity: 0.99 per mille as Acetic acid, an increase of 0.34 per mille since 3rd May, 1911.

Total Acidity: 5.9 per mille as Tartaric acid.

Glycerine (on 28th November, 1911): 0.736 grs. per 100 ccm. wine.

Alcohol-Glycerine ratio is 100: 8.

It has a strong, fine bouquet, reminding one of "Witzenberg," which is likewise made from White French grapes, and has a pleasant, clean taste.

3. Greengrape for Sherry. Vintage 1911.

Pressed on 10th February, 1911.

Composition of must: Sugar = 24.7° Balling.
Acidity = 6.77 per mille as Tartaric acid.

The must fermented with the husks but without the stalks for 24 hours in an open cement tank, and was then transferred to a stukvat to undergo a closed fermentation.

Since this must was to give a Sherry wine, 5 lbs. of plaster of Paris was added per ton of grapes before the fermentation had started. Further 8 oz. potassium metabisulphite was added forthwith to the tank of about 2½ leaguers of must (*i.e.*, about 100 mg. sulphur dioxide per litre must, *since the initial temperature was as high as* 33° *C*. Then the fermentation was started with a pure culture of GB3 (about ½% of starter to must), and the cake of dops repeatedly worked under.

After 24 hours, *i.e.*, on the 11th, the must was transferred to a stukvat. After a fermentation of under 24 hours in the stukvat, *i.e.*, on Sunday, the 12th, the temperature had gone up to 41°C., *whilst a most active fermentation was going on.* On account of this high temperature the must was immediately racked over into another stukvat, when the temperature went down somewhat, and the fermentation continued. On the 21st February, 1911, thus after eleven days, the fermentation had ceased. On the 6th March the wine was racked over into another stukvat, when a slight fermentation again set in and decomposed whatever sugar had been left.

On the 27th March, 1911, it was fairly bright, and a nice, sound, full-bodied wine.

Its composition is shown below:—

Alcohol (on 27thApril, 1911)	15.19 volume per cent.
Total Acidity (8th May, 1911)	5.51% as Tartaric acid
Volatile acidity	1.08% as Acetic acid.
Glycerine (24th Nov., 1911)	1.1 grms. per 100 ccm. wine.
Alcohol (formed by fermentation)	: Glycerine = 100 : 9.

Some of this wine that fermented in a hogshead, and whose maximum temperature was only 39° C., had a volatile acidity of only 0.9 per mille as Acetic acid. On the 14th June this wine was fortified to 17 volume per cent. alcohol by means of a wine-brandy of 62 volume per cent. alcohol. This was done so as to bring the wine up to the strength of a sherry.

The following three experiments were now made with the wine:—

(*a*) One hogshead was filled with it. This wine on the 6th June, 1912, when 16 months old, had not matured much, and did not show much of a sherry character.

(*b*) Three hogsheads were made 4/5ths full and stored in the cellar, and the bungholes loosely closed. When 16 months old this wine had a very *marked sherry* character, was twice as dark in colour as (*a*), and certainly promised well for a good oleroso sherry.

(*c*) One hogshead was made 4/5ths full and left lying in the sun during the summer months. It was rolled into the cellar on the 4th April, 1912. It is still darker in colour than the former, has a nice, strong sherry bouquet, and gives the impression of a three-year-old wine.

As far as the action of the pure levures is concerned, the following must be particularly noted:

(1) That *the maximum fermentation-temperature was 41° C.* Most oenologues in Europe reckon that 38-40° C. is the maximum temperature at which the vinous fermentation can still take place. In the above we have seen that A VERY VIGOROUS

FERMENTATION WAS STILL KEPT UP BY THE PURE LEVURE, GB3, AT 41° C.

(2) It succeeded under such extreme difficulties, *in fermenting the wine dry*, and forming 15.19 volume per cent. alcohol, which means 10 volume per cent. alcohol for about 163 grs. sugar per litre must, or 96% of the total sugar decomposed to form alcohol. This, of course, is *a very high yield of alcohol.*

(3) *The high volatile acidity is due to the excessively high temperature.* In the hogshead where the maximum temperature was two degrees lower than in the stukvat, the volatile acidity of the wine was 0.18% lower than that of the wine in the stukvat. That this volatile acid is *principally formed by the pure levures themselves, and not by acetic bacteria,* is evident from the fact that the wine remained sound and showed no bacteria to speak of. Before it was fortified, expert tasters declared it to be a very fine, full-bodied, *perfectly sound wine.* They thought it could hardly have more than 0.5% volatile acid. A spontaneous vinous fermentation at 41° C. will in almost every case get stuck, and give way to a mannitic fermentation, the result being a sweetish-sour wine, that ends its life in a spirit-still. Such wines have repeatedly been sent in to me for examination. The cause of the disease was in every case a spontaneous vinous fermentation at too high (above 37° C.) a temperature.

The above experience shows that it is possible to make a perfectly sound, heavy, dry wine even at very high temperatures by using a good pure levure, such as GB3.

(4) That the amount of glycerine formed is fairly high.

4. GREENGRAPE fermented:

A. WITHOUT HUSKS.
B. WITH HUSKS.

Composition of must:

A. Sugar = 26.4° Balling; total acidity = 6.19 per mille as Tartaric acid.

B. Sugar = 26.3° Balling; total acidity = 6.24 per mille as Tartaric acid.

A. was fermented all along in a stukvat (closed fermentation); B. was fermented in a cement tank (open) for 48 hours, and was then transferred to a stukvat.

	A.	B.
Fermentation-temperature minimum	24.5° C.	25° C.
Fermentation-temperature maximum	36° C.	35° C.

Both were started with a pure culture of GB3 as soon as the grapes had been crushed. They were both pressed on the 13th February.

Since the wine of A. was still somewhat sweetish on 14th March, 1911, it was again inoculated with GB3 on this date, and racked over. After a few days a fermentation had set in and decomposed the remaining sugar. The wine of B. was dry on the 3rd March. This was to be expected, since the levures here got much more air than in case of A.

Both wines were analysed on the 3rd May, 1911, with the following results:

Alcohol: A 15.23 volume per cent.; B. 14.71 volume per cent.
Total Acidity: A. 5.8 per mille as Tart. acid; B. 5 per mille as Tart. acid.
Volatile Acidity: A. 0.58 per mille as Acetic acid; B. 0.61 per mille as Acetic acid.

The main differences between the closed and the open fermentation may briefly be summarised as follows:

(1) The wine sooner ferments dry with an open fermentation (B) than with a closed fermentation (A).

(2) The alcohol lost by evaporation during an open fermentation is so considerable that the wine B. has 0.52 *volume per cent. alcohol* less than wine A., although the two musts had originally practically the same amount of sugar.

(3) In a fermentation with the dops (open) more fixed acid is lost to the wine than in the other case.

(4) The volatile acid in B. is slightly higher than in A. (closed), although the maximum temperature was higher in A. than in B.

(5) But the main difference is that the wine that was subjected to a closed fermentation without the dops, is a *fine, clean, pleasant* wine, whereas the other is a *coarse, ordinary* wine, far inferior to the first. The grapes were of the same quality and from the same plot of vines in both cases.

(6) It will be noticed that the wine A. has over 15 volume per cent. alcohol.

5. Greengrape (Sauternes). Vintage 1911.

By removing half of the leaves of the vines when the grapes were well ripe, and leaving them exposed to the sun on the vines for about a fortnight, the sugar went up to 29.5° Balling.

The grapes were crushed and the juice pressed out on 17th February, 1911. To just under one half-aum must was added 100 grs. Potassium metabisulphite (*i.e.*, 700 mg. per litre must sulphur dioxide). Since there was no fermentation noticeable on the 25th February, 1911, the must was exposed to the air in an open tub for about eight hours and then put back into the cask. Thereupon a fermentation slowly set in. On the 26th March, *i.e.*, five weeks after crushing, the wine was quite bright and had a nice bouquet.

Analysed on the 4th May, 1911, it gave the following results:

Alcohol .. .. 15.29 volume per cent.
Total Acidity .. .. 5.01 per mille as Tartaric acid.
Volatile Acidity .. .. 0.99 volume per cent. as Acetic acid.
Glycerine on 23rd Nov., 1911 1.25 grs. per 100 ccm wine.

This wine was then *still sweet*. Later on it again fermented, till on the 18th October, 1911 (when eight months old), it was *practically dry*. An analysis made on this date gave 17.14 VOLUME PER CENT. ALCOHOL. The important point here is the *extremely high percentage of alcohol* in the wine. In the light of such data it becomes ridiculous to proclaim 15 volume per cent. as the maximum alcoholic strength of a natural wine.

No pure levures were used in this case, but the high dosis of bisulphite enabled only the most active wine-levures to develop, and the total quantity of must was very small. Had the quantity of must been twenty times as large as it was in this case, the same result would not have been obtained without using pure levures.

It should be observed that the amount of *glycerine* formed was very *high*.

6. PONTAC (PORT TYPE). Vintage 1912.

Pressed on 14th February, 1912.
Composition of must:
Sugar = 24° Balling.
Total Acidity = 9.8 per mille as Tartaric acid.

Inoculated with a pure culture of HeA3. On the 16th February, 1912, after 36 hours of fermentation in an open cement tank and in contact with the dops, the must showed 9° on the Balling Saccharometer, and was then drawn off. Temperature:

Minimum (initial) .. .. 25° C.
Maximum (when must drawn off) 34° C.

The must and the press-must were mixed and partially fortified by means of a wine-brandy of 68 volume per cent. alcohol. The fermentation continued for another 24 hours, and finally stopped on the 17th February, 1912. The wine was then only a little sweetish, and had a nicely dark colour. It has a pleasant taste, and constitutes a very valuable wine.

On the 3rd June, 1912, it was analysed, and gave the following results:

Alcohol .. .. 16.84 volume per cent.
Total Acidity as Tartaric acid 7.00 per mille.
Volatile acid as Acetic acid .. 0.69%.
Sugar .. .. 1.4%.

Notes.

(1) It will be observed that the total acidity of the Pontac must was again very high.

(2) The all important point here is the fact that the levure HeA3 continued the fermentation for 24 hours after the fortification, and did not stop until the very high figure of 16.84 volume per cent. alcohol had been reached. This means that in making sweet wines on the Port system, one must put the final strength of the wine at 17 volume per cent. alcohol in order to avoid a secondary fermentation.

(3) It will be observed that the wine has kept some (1.4%) sugar.

On the foregoing pages we have got some physiological studies about the pure levures cultivated and selected by the author. These researches will be extended in future, and the morphology of these levures studied in due course.

In conclusion I have much pleasure in thanking Mr. W Wagener, Assistant Government Viticulturist, for the valuable assistance he has given me during the course of the above studies. He is responsible for all the analyses quoted in this paper.

Transmutation of Elements. — Two papers, which may possibly prove to be epoch-marking, were read at the meeting of the Chemical Society, London, on the 6th February. One of these, by Sir William Ramsay, was entitled "The presence of helium in the gas from the interior of an *X*-ray tube." and the other, by Professor J. Norman Collie and Mr. H. Patterson, was on "The presence of neon in hydrogen after the passage of the electric discharge through hydrogen at low pressures." The importance of the announcements made by the authors lies in the virtual claim which they make to have done one of two things: either (1) to have achieved, clearly and definitely, the transmutation of elements, or (2) to have succeeded in evolving matter from energy; or, to put it in another way, to have formed material atoms by synthesis. The alchemist, who used to dream of turning iron into gold, was regarded with amused interest as recently as twenty years ago, but when Sir William Ramsay first announced his discovery that radium broke down into helium and niton (not to mention his later assertions regarding the production of lithium from copper, and of carbon dioxide from thorium and silicon under the action of niton), the interest in the old alchemists and their fancies was heightened, and there was a corresponding diminution of the amusement. Ramsay's discovery, however, had reference to the spontaneous breaking down of heavy elements into lighter ones, while the announcements now made affirm the building up of the light elements at the opposite end of the scale. This synthesis, moreover, is declared to be one under human control, whereas the breaking down of the heavy elements is a process which man has not hitherto found means either to stay or hasten. If their experiments are confirmed, Collie and Patterson have succeeded either in transmuting still simpler elements into neon and helium, or else, as it has been put, they have themselves created, out of the ether, elements of extreme simplicity. Sir William Ramsay's announcement in February consisted mainly in this, that, on heating old X-ray bulbs to 300°, and collecting the gas, he found it to contain helium, the source of which, in the present state of knowledge, he was at a loss to account for. Professor Norman Collie and Mr. Patterson, taking all possible precautions to secure the purity of the gas used as the basis of their experiments, sparked hydrogen at low pressure, and, anticipating to obtain helium, which would in itself have been sufficiently remarkable, the astonishing discovery of the resulting presence of neon was made. The tube containing the hydrogen to be sparked was enveloped in a second tube, and it appeared that helium was first formed by the sparking of the hydrogen, and passed through the glass walls of the inner tube with high velocity under the action of the discharge. If at this stage it met with oxygen the result seemed to be that neon (atomic weight = 20) was produced by the combination of the helium (atomic weight = 4) with oxygen (atomic weight = 16). Professor Collie was quite satisfied that helium and neon had been produced from substances in which they were not previously present. There were, he said, various possibilities: it might be that the elements of the tube in the electrodes gave neon or helium under the influence of the discharge. This gave them ten or a dozen elements to choose from as the source. Again, there was the chance that the hydrogen was the source. Or it was possible that they were dealing with a primordial form of matter. At any rate, one thing seemed certain; the elements could be changed, and they could be changed in a way very different from the way in which radium was changed. In the case of radium the process could neither be hastened nor retarded; but the present phenomenon was artificial, and further, the process was occurring at the other end of the system of the atoms, producing elements of low atomic weight. The old idea of the transmutation of elements had to be altered. The President of the Chemical Society, Professor Arthur Smithells, B.Sc., F.R.S., Professor of Chemistry in the University of Leeds, who moved that the thanks of the Society be accorded to the authors for their momentous communication, remarked that he was somewhat breathless at the announcements just made, and that for dramatic interest the papers which they had heard read had never been surpassed in the history of the Society. The announcements made by the authors are of a startling nature, and might have excited scepticism and even ridicule but for previous work equally revolutionary in character. The interest in chemical discovery seems now to have finally shifted from the mere filling up of blanks in the table of the chemical elements to the problems of controlling the forces and velocities inherent in the ether of space in such a manner as virtually to create something out of nothing.

TRANSACTIONS OF SOCIETIES.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, December 21st: W. R. Dowling, M.I.M.M., President, in the chair.—"Atomic weights and a new theory of chemical affinity.": Dr. J. **Moir.** The author had previously conceived (see *Trans. Chem. Soc.* 1909, p. 1752; also *Trans. Roy. Soc. S. Afr.*, vol. 1, p. 413, and *Rept. S.A. Ass. Adv. Sc.*, 1909, p. 188) that the atom of each element is built up of a large non-valent part, generally of integral atomic weight, and a small fraction representing and proportional to the valency. The equivalent weight of this affinity-element or proton (μ) was assumed to be .009 of that of the hydrogen atom. The author now proposes the conception that every bond in the current chemical formulæ represents a definite quantity of an actual substance, and possesses weight, this weight being double of that previously assumed, namely, .018 of the the weight of the hydrogen atom. Numerous examples are given in support of the view advanced.—"Some observations of the graphite deposits of Madagascar and Africa": E. R. **Bawden.** General observations were made regarding the occurrence of graphite in Madagascar, especially in the Province of Imernia, and in Nyasaland, Rhodesia, and Angoniland.

Saturday, January 18th: W. R. Dowling, M.I.M.M., President, in the chair.—"A new method of precipitation by zinc": J. S. **MacArthur.** At the first introduction of the cyanide process in the metallurgy of gold the recovery of the gold from the cyanide solution was effected by precipitation by means of thread-like shavings of zinc. Except for the use of zinc dust in the Merrill method, filiform zinc is still supreme, but its use has certain disadvantages. These the author overcomes by the use of small zinc wafers.—"Cyaniding of gold and silver ore at Caveira Mine, Portugal": J. **Hutton.** Details were given of the practical application of MacArthur's zinc wafer precipitation method. The advantages were: low consumption of zinc, obviation of acid treatment, large saving in smelting charges and in labour, and maintenance of an even zinc surface in the boxes, free from channelling.

Saturday, February 15th: W. R. Dowling, M.I.M.M., President in the chair.—"The action of oxidizers in cyaniding": M. **Green.** Potassium permanganate is sometimes used on the Rand as an "aid to cyaniding," but its action seems to be imperfectly understood. The permanganate is added to the treatment charge, and then run on to the cyanide solution. The author found that in the presence of much reducing matter the treatment solution to which an excess of permanganate had been added would not have a very pronounced effect so far as the oxidation of the reducer is concerned. But where the quantity of reducing matter is small, such a solution would in this connection be distinctly useful. If, however, the value of the permanganate is supposed to lie in its yielding a solution capable of dissolving the gold content of the charge more readily, the author found the opposite to be the case. Another oxidizer of unknown action is potassium ferricyanide. Its effect in causing the gold to dissolve more rapidly in a solution of potassium cyanide does not appear to be due to any reaction between the ferricyanide and the cyanide, but to some process independent of the reduction of the former by the latter. It would seem, therefore, that the assistance of oxidizers in the solution of gold is of a secondary nature.

Geological Society of South Africa.—Monday, January 20th: Mr. H. S. Harger, President, in the chair.—"Some features associated with the denudation of the South African continent" (Presidential address): H. S. **Harger.** In order that the vast extent of denudation to which the subcontinent has been subjected might be fully grasped, the first portion of the address was devoted to a description of the configuration of South Africa at the close of the Karroo period—that of a huge table land, varying in altitude between 8,000 and 13,000 feet above sea level. In Jurassic times the Karroo sediments had reached an altitude of fully 8,000 feet (resulting from the degradation of a vast unknown area) when the great volcanic outbursts of the Drakensberg piled about 5,000 feet of basic lavas over the southern portion of the continent. After the close of the Karroo period and cessation of igneous activity, an era of continuous denudation ensued, and in the course of ages the huge peneplain was dissected downwards by rivers which have cut through ranges to depths of 3,000 feet, or carved through at least 1,000 feet of hard dolomite and diabase. During the earlier stages of denudation the country passed through much heavier rainfall than is now experienced, and river beds now perennially dry have banks fifty feet high and are strewn with boulders of considerable size. In addition to aqueous denudation, wind erosion has in some places carved great valleys out of the rock formations, and scarified not only basalt dykes but even quartz, jasper, agate, and chalcedony. Incidentally the author expressed the view that millions of diamonds from the upper Kimberlite occurrences must have been carried into the Atlantic, not only by the Orange River, but also into the ocean facing Luderitzland by other rivers which have ceased to exist.

Monday, February 24th: A. L. Hall, B.A., F.G.S., President, in the chair.—"Structural features of the Western Witwatersrand": Dr. E. T. **Mellor.** A comprehensive description of the geology of the country extending westward from the neighbourhood of Roodepoort as far as the furthest outcrops of the Witwatersrand System in that direction which can be directly connected with the main Witwatersrand area, including the whole of the West Rand, extending south-westwards as far as the neighbourhood of Bank, on the Potchefstroom railway line, and embracing an area of over 400 square miles.

South African Institute of Electrical Engineers.—Thursday, February 20th: Mr. J. W. Kirkland, President, in the chair.—"Notes on three-phase winding equipments": L. B. **Woodworth.** In view of the interdependence of the various items constituting the chain of the winding system, various points were mentioned to which attention should be given in the design and installation of feeder, main control and reversing switches, in the regular and systematic inspection of contacts, operating and trip gear, and in the testing, frequent cleaning, and changing of oil. Recommendations were made regarding the type of switch gear to be employed for solution and circulating pump motors, the provision and arrangement of terminal panels, the range of overload trips on feeder and main control panels, the location of the electrically-operated over-winding device. The rotor circuit was then more fully discussed, and the question of static dischargers considered in this connection, particular attention being given to the occurrence of flash-overs at various points.

Cape Chemical Society.—Friday, February 28th: Dr. C. F. Juritz, M.A., F.I.C., President, in the chair.—"Determination of nicotine in tobacco and tobacco extracts": Prof. P. D. **Hahn.** A series of determinations made by the distillation method yielded results differing very considerably from those obtained when the nicotine was extracted by means of ether, and it was suggested that other substances than nicotine were dissolved out when the ether extraction method was employed, and thus the proportion of nicotine was made to appear higher than it actually was.—"Note on the occurrence of Tantalite and Columbite": Prof. P. D. **Hahn.** Descriptions (with analytical results) were given of minerals occurring in the north-west of the Cape Province, near the Orange River mouth.

ON VEINS AND INCLUSIONS IN THE STELLENBOSCH GRANITE.

By Prof. Samuel James Shand, D.Sc., Ph.D.

Plates 4, 5, and 6.

A series of comparative studies of the granite masses which bulk so largely in the foundations of the Western Province might produce new evidence regarding the early geological history of the continent. The present notes can have little interest apart from their relation to that larger investigation, of which they may be considered as an isolated chapter. It is to be hoped that, as the number of workers increases, other chapters will be completed from time to time and will find their places in the series.

The large mass of granite lying to the west of Stellenbosch presents few extensive exposures, but small outcrops are fairly numerous. In the immediate neighbourhood of the village there are three points where quarrying operations have been conducted upon a small scale. The first of these is by the bridge over Kromme Rivier, a short distance beyond Bosman's Crossing station. Here the granite is in close proximity to the Malmesbury slates, which are met about two hundred yards up stream. Micaceous inclusions and tourmaline veins are seen in the granite at this point, but these are neither more numerous than, nor in any respect different from, corresponding structures which occur in the heart of the granite area and are described below. The Malmesbury rocks are altered to a compact, splintery mica-hornfels, but show no injections of granite.

A much better exposure is met at Platte Klip, half a mile to the west. This is a bare surface of granite measuring one hundred and thirty by fifty paces, and exfoliating in slabs of from one to two feet in thickness. A few such slabs have been quarried for kerbstones. In this small exposure there is quite a remarkable development of veins and inclusions, which fall into the following classes:—

I. Segregation veins of aplite and pegmatite.
II. Fissure veins with infilling of tourmaline.
III. Inclusions (xenoliths) of various types.

- (*a*) Micaceous xenoliths of very dark colour and decimillimetre grain (*i.e.*, average size of grain 0.1 to 1.0 millimetre).
- (*b*) Micaceous xenoliths of coarser grain (1 to 2 mm.).
- (*c*) Similar to (*b*), but containing large crystals of red felspar.
- (*d*) Fine-grained xenoliths resembling microgranite and containing more felspar than mica.
- (*e*) Granite xenoliths. A single boulder, some nine feet in diameter, appears to be an inclusion of earlier within the later granite. Its relation to the latter is clearly shown in photograph No. 1.

The next exposure to be described is met close to the main road, about half-a-mile north-east of Vlottenberg station. This is in some respects the best exposure of all, because, although of small superficial area, it has been more deeply quarried than the other exposures. True segregation-veins are not seen here, but tourmalinised fissure-veins intersect the granite abundantly. Inclusions are of three types:—

(*a*), (*b*) Micaceous xenoliths similar to (*a*) and (*b*) as described above.

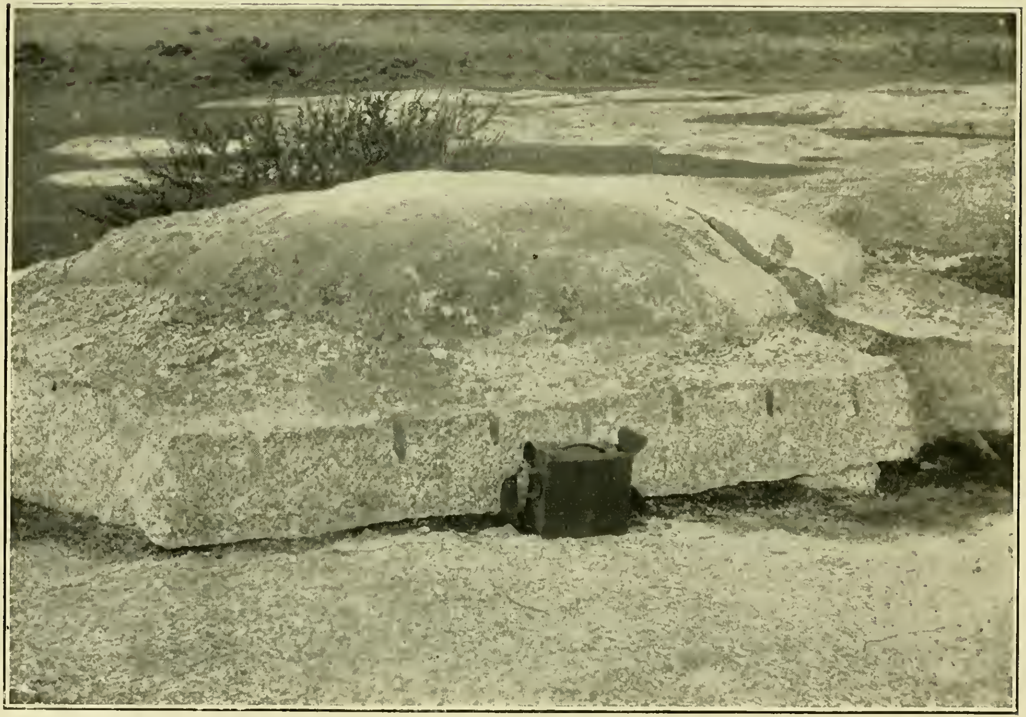
(*f*) Tourmaline-bearing xenoliths.

These inclusions are scattered indiscriminately through the rock, but they show a striking point of difference, which is apparent even at a little distance. It consists in this, that the tourmaline-bearing xenoliths are surrounded in every case by a white collar of large felspar crystals, this feature being absent from the micaceous xenoliths. Photograph No. 2 shows such a xenolith in place within the granite, and brings out the collar quite distinctly. The average size of the xenoliths of both kinds approaches that of a cricket ball.

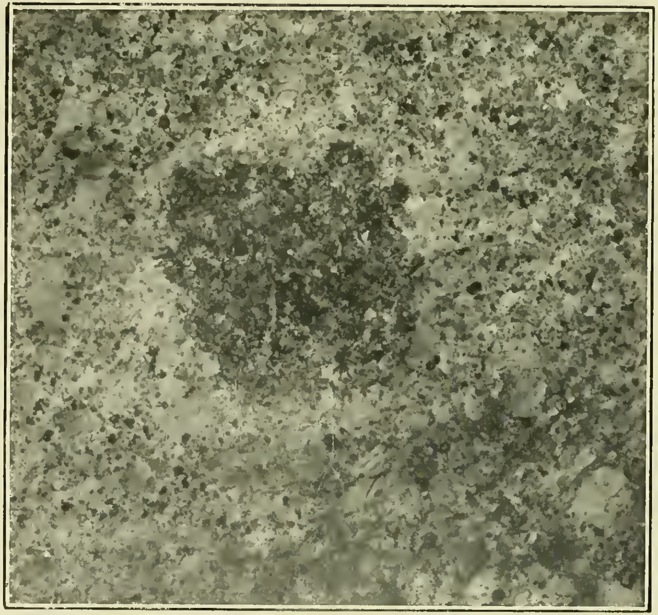
Microscopic Characters of the Rocks.

The *granite* has precisely similar characters over the whole area, and does not differ externally from the Lion's Head granite. It contains very numerous large phenocrysts of microcline in the form of Carlsbad twins. These range from two to four inches in diameter. The majority of the smaller felspars in the base of the rock belong to microcline, with the exception of a quite small proportion in which the twinning and extinction are those of albite. Quartz is very abundant, together with the usual brown biotite and minute crystals of apatite and zircon. Tourmaline does not appear to be a usual primary constituent of the granite.

The *segregation veins* are chiefly reddish-grey aplites of fairly uniform millimetre grain. The veins range from a fraction of an inch up to about eighteeen inches in width, and can be traced for considerable distances through the granite. In places they pass, either marginally or centrally, into thin pegmatites. Under the microscope the aplite is seen to be composed almost entirely of uniform anhedral grains of microcline and quartz, with a few flakes of biotite and, as a novelty, one or two crystals of muscovite. Tourmaline has not been observed in the aplites. The pegmatite veins are seldom more than an inch in thickness; they show well-developed graphic intergrowths of quartz and microcline, and here and there contain radiating bundles of tourmaline needles. An intermediate stage between aplite and pegmatite is apparent where felspar phenocrysts are developed in the aplitic base, producing a rock which must be described as granite-porphyry. Some writers would restrict the name granite-porphyry to aschistic dyke-rocks, that is, such as differ only in structure, but not at all in composition, from the parent rock.

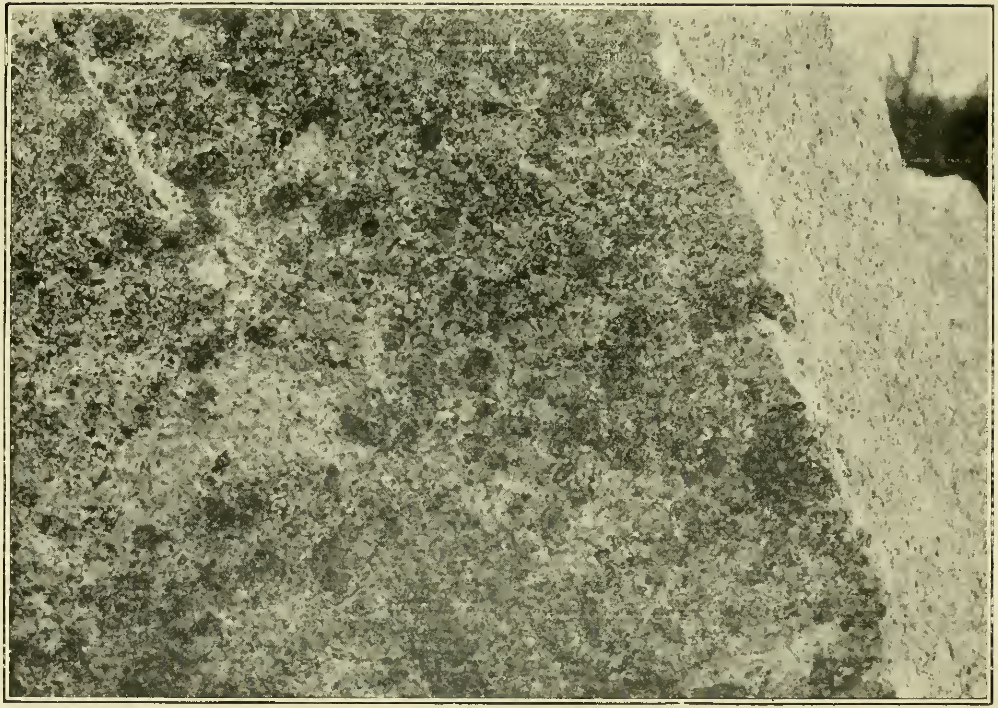


No. 1.—Large xenolith of granite in granite. (Platte Klip.)



No. 2.—Tourmaline xenolith, showing the white "collar." (About one-third natural size.)

No. 3.—Wall of vein, showing felspar replaced by tourmaline.



No. 4.—Nearer view of No. 3.

The dyke-rock referred to here is distinctly diaschistic (leucocratic) in all its facies, whether aplitic, porphyritic, or pegmatitic. Among segregation veins, however, truly aschistic types are never found, and I know of no exception to the rule that *segregation veins are always more leucocratic* * *than the rocks which contain them.* If the essential similarity of composition between granite-aplite, granite-porphyry, and granite-pegmatite be admitted, the differences between these types are seen to be purely structural, and, as such, they find a ready explanation in terms of the conditions under which the molten rock solidified. It is a matter of everyday chemical practice to procure a yield of small crystals of uniform size from a solution by agitating it during the act of crystallisation, whereas the same solution, if permitted to crystallise without disturbance, will yield relatively few crystals of much larger size. A change from tranquility to agitation before crystallisation is completed will produce a mixed crop of large and small crystals. All the essential differences between aplites, porphyries, and pegmatites can be explained by such differences in the condition attending their crystallisation.

An exceptional facies of the aplite is exhibited by a block of rock which was found detached from its matrix at a spot where the granite has been excavated. The bulk of this block consists of an exceedingly fine-grained (0.1 mm.) aggregate of microcline and quartz, in which there lie large sheets of biotite. Each such sheet has a width which may be as much as three centimetres, while the thickness of the sheet is not more than half a millimetre. These sheets are not single crystals, but each sheet consists of a great number of tiny scales arranged in parallel position and touching or even overlapping one another. There is no parallelism in the orientation of the different sheets, which lie at all angles in the rock and largely determine its fracture. Under the microscope the biotite is seen to include grains of quartz and felspar very numerously, indicating that it was formed later than these. A good deal of magnetite is present in the form of rounded grains, together with a little muscovite and zircon. In the middle of this fine-grained rock there is a one-inch vein of tourmaline pegmatite similar to those mentioned above. Although this block of rock was not actually found in place in the granite, it seems clear that it represents an abnormal development of one of the aplite-pegmatite veins, but I am at a loss to account for the peculiar development of the mica. The only rock in which I can recall any similar structure is the mica-peridotite (scyelite) of Caithness, Scotland, where the mica has the very same habit and conditions the fracture of the rock just as in this case.

The *fissure veins* are narrow cracks which can be traced for considerable distances in the granite. They are in part empty, but to a large extent filled with tourmaline which has developed in the

* The case of the nepheline pegmatites precludes one from saying *more acid.*

felspars on either wall. A noticeable feature, which is brought out quite clearly in photographs Nos. 3 and 4, is that the tourmalinisation has affected chiefly the porphyritic felspars of the granite, so that these are often entirely replaced by tourmaline through a thickness of one or two millimetres on either side of the fissure. These pseudomorphs retain the form of the felspar crystals perfectly.

In connection with these veins, in which the tourmaline is clearly secondary, I wish to mention here a peculiar brecciated rock of which numerous blocks are to be found on the south slopes of Papagaaisberg, from the level of the Plateau nearly to the summit. This rock has a black base in which there are set abundant fragments of white quartzite, the whole having the appearance of a fault-breccia. Under the microscope the quartzite shows a typical mosaic of interlocking quartz grains, through which tiny crystals of tourmaline, with pleochroism from brown to colourless, are scattered. The dark base of the rock seems to be made up entirely of brown tourmaline and decomposition products, with also occasional fragments of deep blue tourmaline. Some crystals are half brown, half blue. This rock is not exposed in place anywhere on the hill, but the abundance of weathered blocks of it suggests that a very extensive brecciated tourmaline vein passes right through the hill. Indications of cassiterite or other useful ores are, unfortunately, absent. The source of the quartzite fragments is not obvious. There are no such pure quartz rocks in the Malmesbury of this neighbourhood, and it would be contrary to all experience to suppose that the vein penetrated the former covering of Table Mountain Sandstone. The mosaic structure of the quartzite suggests that the latter was recrystallised at a high temperature. It is unfortunate that the relations of this interesting vein to the granite and to the Malmesbury cannot be definitely ascertained.

Micaceous xenoliths, type (a). These very fine-grained micaceous xenoliths contain spongy brown and green biotite as their chief constituent. Both quartz and cordierite are present, but owing to the difficulty of distinguishing between these two minerals it is not possible to determine their relative abundance. Occasional fragments of larger size than the average afforded in some cases the positive uniaxial interference figure of quartz, in others the negative biaxial figure of cordierite; while the faint bluish colour and pleochroism of the latter mineral were also discernible with the naked eye in some specimens. A few turbid crystals of albite or oligoclase are present, and little needles of sillimanite are rather plentiful as inclusions in the other minerals. From these characters it is clear that the xenoliths in question are altered fragments of Malmesbury slate—a fact which in the field is so obvious as scarcely to require demonstration.

Type (b). In the coarser-grained xenoliths quartz is reduced in quantity and microcline is, after biotite, the most important constituent. Cordierite was not certainly identified, but is not necessarily absent on that account. Sillimanite is absent from such specimens as have been examined. Chloritic alteration products (of biotite?) are commonly present. Although the extreme examples of type (*b*) are so different from type (*a*) as described above, yet such a complete series of intermediate varieties is observed in the field that it is impossible to draw a sharp line between (*a*) and (*b*), and the latter must be recognised as a further stage in the alteration of the Malmesbury by the granite.

Type (*c*). These xenoliths resemble type (*b*), but contain large crystals of oligoclase. The latter are not true phenocrysts, being of later origin than the base in which they lie, and are, therefore, of the same nature as the eyes of many eyed-gneisses. One may refer these xenoliths to the Malmesbury without unduly stretching the facts, but it must be admitted that positive proof of such a derivation would be exceedingly difficult to furnish, the product being many steps removed from the supposed raw material.

Type (*d*). Xenoliths of this class are not essentially different from the aplites which have been described above. Biotite is, however, more abundant in the former than in the latter. The grain is decimillimetre, and the texture typically granitic. I am not prepared to make any suggestion as to the origin of these xenoliths; they are widely different from the others.

Type (*e*). There seems to be no reason to doubt that this is really an inclusion of older within younger granite. It is interesting in view of the possibility that there have been two distinct periods of intrusion in this area, but it would be absurd to form any conclusion from an isolated instance. The boulder contains a little more biotite than the surrounding granite; it is also rather smaller grained and has fewer phenocrysts. The average grain, excluding the phenocrysts, is about two millimetres. Oligoclase and microcline are about equally abundant, and a little muscovite is present.

Type (*f*). In the tourmaline xenoliths quartz and tourmaline are the chief constituents. The latter mineral is brown (rarely blue) in colour and does not have the radial acicular structure of most secondary tourmaline; it forms stout crystals which are moulded round the quartz. Fresh oligoclase and microcline are present, also some large plagioclases which, though turbid and decomposed, are not tourmalinised. In this instance, therefore, the tourmaline does not seem to have been formed at the expense of felspar. Each xenolith of this type is surrounded, as already mentioned, by a zone of large fresh felspars. These xenoliths (if they are xenoliths and not infilled drusy cavities) are unique in my experience, and I am as yet quite unable to explain their formation.*

* My friend Mr. F. P. Mennell writes me that he has found entirely similar inclusions in the Dartmoor granite, Devonshire, and he intends to describe them shortly. It is to be hoped that he may be able to indicate their origin.

SOUTH AFRICA—AND THE UNDERGRADUATE.

By A. E. Griffiths, M.A.

Proem.—In the following paper an attempt has been made to maintain that there exists some correlation between the Education of the Undergraduate and the "Political" problems of South Africa. By the term political we mean those things that appertain to the welfare of the State, as distinguished from those that concern "party politics."

We are well aware that there are many who will strongly deprecate any such attempt on our part, and who will aver that the Undergraduate's studies should be completely detached from the affairs of the State. They will claim that our Undergraduate should be left unmolested to pursue a purely intellectual life during those years he may call his own.

The urgency of our National problems is the only excuse we would offer.

The Undergraduate is the hope of South Africa. To the idle and flippant this sounds a merry jest; but never did merry jest veil a deeper or a more solemn truth. We who have left behind us our light-hearted, irresponsible days—when not even the youngest of us could make a mistake, are arrested by the grave, yet fascinating, problems which no longer loom in the South African mists, but which in our very midst are assuming a definite and an aggressive form. Such problems only those who are wrapped in a complete self-complacency and busied in furthering selfish ends, either cannot, or will not, see; those who do see are utterly astonished at their magnitude and increasing complexity.

Now did we not know that forces are at work which seriously affect the existence of the white races of South Africa, we would admit that it were wise to leave our Undergraduate to enjoy his halcyon days in Arcadia, before the Fates rudely fling him into the arena of a prosaic world. *Et ego in Arcadia vixi.* But since our National problems are so insistent, so gravely menacing, it were wiser to awaken him to the facts of his changing environment that he may brace his sinews for the great work in front of him. The White Man's Burden is a trite saying—but the South African Undergraduate's share is herculean. But he does not know it.

A By-gone South Africa.

Those of us who have some knowledge of South African history, who have talked with the still-surviving links of a golden age, can readily conjure up the Arcadia of the Myths. The idyllic life of these people, their flocks, their herds, their cellars or rich Falerian "with beaded bubbles winking at the brim," their homely interchange of hospitality, the glories of the chase, the silent beauty of the veld, the magic stillness of the night, her splendorous stars—here was Arcadia! No wonder that amid such idyllic surroundings young Corydon piped his amorous lays to some blue-eyed "Amaryllis in the shade" what time his Nestorian sire meted out a rude justice to his hinds! No wonder that the patriarchs of the village were unconscious of the silent growth of evolutionary and revolutionary forces! A glamour was upon the land and upon its people: and we venture to say that in many parts of South Africa the spell is yet unbroken. Why break the spell? Fifty years ago the spell was the spell of Arcadia; in this year of grace 1912 the spell is the spell of the Fool's Paradise. We must arouse young Corydon, we must awaken him to the fact that South Africa is no longer a land for the Lotus-eater, but a land bristling with problems whose solution calls for all the virtues that best become a man—undaunted fortitude, a high spirit of faith, hard work, deep-thinking, justice and self-sacrifice.

The South Africa of To-day.

What is this South Africa of to-day? What are these problems? Let us clearly, and without fear, state facts as they are. We have been deluded, or have deluded ourselves, too long; and the immediate present, not the shadowy and distant future, demands that our Undergraduate should understand them, should realise the trend of mischievous forces that he may set his face dead against them. In thus understanding lies his only hope of proving himself equal to his National responsibilities.

In reflecting upon our present social and industrial conditions we are at once struck by the dominating influence of the Mines. The Mines present a sociological problem unique in the history of man. They attract and they repel. Conscious of their tremendous power in dictating terms, and somewhat arrogant in asserting selfish interests, they have not yet realised what a telling force for good they can become in influencing our National life; nor yet have they realised the full significance and the far-reaching effects of the evils that are being bred in their midst. Now, we cannot deny that the Mines act and re-act upon every phase of our being. There is no South African town which does not send its representative young men, no Native tribe south of the Zambesi which does not send its thousands, to Johannesburg and to Kimberley. The Native returns to his kraal no longer ingenuous, stirred with a discontent not exactly divine; the young South African remains to imbibe twentieth-century ideas. What are these ideas? We may safely say that the spirit of the Mines is the adoration of the Golden Calf; that the High Priests of that cult and our young acolytes in their zealous devotion are in danger of forgetting their duty to their country, their homes and themselves. Are we surprised, then, that money-hunger is gripping young South Africa? Are we surprised that our social conditions are undergoing a rapid change? That simplicity is fast disappearing? That standards of living are being set up wholly untenable—a luxury characteristic of an Empire in the last drear stage of decrepitude, but fatal to a young people.? Let us not forget that when luxury comes in, all principle, all *virtus* goes out. Let us not forget that the torch of civilisation has been repeatedly carried into Africa; but time and again has that torch flickered out in the atmosphere of luxury. The Phœnician, the Carthaginian, the Greek, the Roman are now the dust of the Sahara. Let us take heed lest we repeat the tale. Such is one problem of the South Africa of to-day.

There is yet another problem of absorbing and immanent interest—one familiar to us all, but, as a rule, studiously avoided. We speak of our Native Question. Statistics, the returns of the 1911 Census, will bring home to us a phenomenon which will give our young Undergraduate sound reason to pause and consider. The actual figures of the population of South Africa are as follow:—European, 1,276,242; Non-European, 4,697,152.

Rate of Increase.—European, 14.28%; Non-European, 15.12%

Numerical Increase.—European, 159,436; Non-European, 638,134.

These returns show that the proportion of Non-Europeans to Europeans is as 19 : 5, and that the Non-European numerical increase is as 4 : 1.

Pursuing the train of thought aroused by these figures, we at once ask: "What are the forces in favour of a necessary increase of the White population?" The answer is simple: "Practically nil. 1. To-day the inlets into South Africa are practically closed to the sweeping tides of European Emigration. 2. The social and economic conditions of our European population are unnaturally hostile to the production of large families." Again we ask: "What are the forces in favour of a continued increase of the Non-European Races?" Summarised they read as follows:—

1. Natural fulfilment of natural functions. 2. Applied Modern Science—Medical and Sanitary. 3. British Citizenship. 4. No inter-tribal slaughters—no Dingaan, no Tchaka.

What are the forces against a large Native increase?

1. Dop. 2. European vices. 3. European diseases. All of which, education, educated Native doctors and chiefs will hold in check.

Net Result.—An overwhelming Native majority within the next four generations. It is clear that the Native remains; the question is: "Do we go out?"

Such, then, is the South Africa our young Undergraduate has to face—a South Africa whose social activities are manifesting a strong tendency towards wrong ideals, and whose Native races are growing conscious of their latent power.

Our Undergraduate's Unique Position.

Our first duty, then, is to bring home to our Undergraduate his unique position. With such an environment he cannot, he must not, claim an inviolable sanctuary for his undergraduate's days, but from his Matriculation upwards he must be disciplined to meet what seems to be an overwhelming responsibility. Let us not forget that the undergraduate of England has thirty million men behind him, and a ruling class which has been bred through centuries of administration; the undergraduates of Canada and of Australia are confronted with no Native problem; the undergraduate of the United States has an enormous preponderance of Whites to give him leisure; the undergraduate of South Africa alone has to maintain the heritage of his fathers intact in the face of odds that are daily increasing. Has he realised this? Have we realised it? Has the present Ministry, or any other South African Ministry ever realised it? We frankly and fearlessly ask the responsible rulers of South Africa: "Do you honestly think your present University system adequate for such an imperial need? Do you think the fifty Examinations through which you drive your young undergraduate before he obtains his M.A. degree, conducive to high thinking and the 'living of laborious days' for his country?" We think not.

Defect of Our University System.

Before we venture with all due deference to find fault with our University system, let us pay a whole-hearted tribute to the good work it has done. Its chief praise is that it has focussed the minds of our people upon the urgent need of Higher Education. Whatever yearnings our people may have had for the intellectual life, it has striven to satisfy. It is insufficient to-day inasmuch as it clings too closely to its original traditions. Most men feel that there is wanting a something in its composition. Were the average intelligent thinker, whose perspective has been adjusted by experience, asked to state his opinion, he would probably say that the system is as though it had been "cast," and, as such, it does not produce an enlightened and a liberal mind. We would go further and say that *it is wanting in a quickening spirit and a leavening atmosphere.* Let us examine this University, since it is, at present, the only fount of our National thought.

In the first place our University has been transplanted from a European soil; it has manifested a growth not in accordance with South African needs; not even its staunchest supporter can honestly affirm that it has adapted itself kindly to its environment. Secondly, it is an Examining Body only, and, true to its functions, it has inaugurated sufficient Examinations to throttle the whole of South Africa—young South Africa is at present gasping for breath. Thirdly, its *alumni* are adherents of Colleges which are not animated by one common ideal whose *fons et* *origo* ought to be the University itself. Let us be honest with ourselves and bluntly ask: "Can anyone deny this indictment?" It is no wonder that under such scholastic conditions our Undergraduate is suffering from mental congestion, and that in such an atmosphere as his own College affords, his outlook is in danger of being narrowed down to the interests of his own particular faction. It is no wonder, we say, that he is blind to the wonderful metamorphosis his own country is undergoing, and that he regards sport as the only serious occupation of his life. It is time we got him on to the heights that he may see for himself away on the horizon the restless churning that heralds the onrush of a tidal wave, whose far-flung edge but now idly laps upon the threshold of his door.

Wanted—One South African University Centre—Residential.

Convinced as we are that no National effort has yet been made to face our National problems, and that the time is now ripe to place them on the table for all men to see and inwardly digest, and that there exists, as yet, no fount of thought at which our Undergraduate may freely imbibe large and generous National ideals, we maintain it is high time our various Educational factions abandoned a fatuous policy in favour of something truly great, truly National, truly Imperial—something worthy of the high traditions of the Race. *The clamant need of our young undergraduate is one South African University centre*—a centre composed not of any one college but of many colleges, all resting beneath the wing of one inspiring Alma Mater; a University which will afford all young South Africans untrammelled opportunities of knowing one another, of detaching themselves from racial and local prejudices, of forming independent judgments, of recognising the great truth that all the virtues are not the sole possession of any one people—whether they be Dutchmen or Englishmen; and of effecting the solidarity of the two White Races of South Africa; a University which will hold the student not as a mere Examination unit but as a sentient being "to be touched to fine issues"; a University which is not the outward symbol of the dry bones of knowledge, but a temple enshrining the quickening spirit of understanding.

"Very pretty, and very Utopian," someone will say. We say that our suggestion is not Utopian; in fact, its great beauty is that it is so feasible. The opportunity and the means of laying the foundation stone have been given us, and it is our duty to lay it; future generations may add to, and complete the superstructure. But why do we delay? Would the inauguration of so magnificent a National conception disturb too many vested interests? Are the needs, the aims, the aspirations of the two great political factions still distinct and at variance? Is the racial equation still of greater import than the National weal? Are we determined to forget that what is to us merely a personal difference is a matter of life or death to our children—*whose trustees we are?* Are we so blind that we will *not* see that a liberal Education, and not a factional ignorance, is the only force that will keep intact the heritage of our fathers? These are no mere rhetorical questions, but blunt questions that call for an honest answer.

The Site of the University.

Assuming, then, that the spirit of common-sense will, sooner or later, touch the minds of our people, and that they will sink their petty interests, and that there will arise a National desire for a National University, where are we to lay the foundation stone? Many voices will be heard in reply. There is but one place. Beneath the shadow of Table Mountain lies the cradle of the Races. That majestic sentinel, inscrutable as the Sphinx, has looked down upon the galleon of Van Riebeeck and the "*Good Hope*" of Victoria. He has listened to the tramp of victorious legions as they have moved into the Hinterland. Whatever we have of tradition and of "atmosphere" is centred about him: and tradition and atmosphere are two potent forces in moulding a National ideal—the one is the mother of a fine sentiment; the other of a humane and liberal outlook. There is nothing mean about Table Mountain; his spirit is magnanimous, his vision limitless, his repose perfect, his beauty unequalled. As a University centre he offers conditions and a setting that rival those which embowered the Lyceum of Aristotle and the Academy of Plato. And we ask: "Is it an idle dream to think that the Cape Peninsula may become the Athens of South Africa—that Athens whose spirit is yet a force in twentieth-century civilisation?" It may be an idle dream to say that it may become, but that it *can* become may be emphatically asserted. Let us not forget that Athens was not built in a day, and that it did not reach the fulness of its glory in its youth. We are a young nation, and to those who contemptuously ask: "What has South Africa done?" we would reply: "It took England five hundred years from the Norman Conquest to produce a Shakespeare, and a thousand years from the accession of Alfred the Great before England's rulers considered Englishmen sufficiently educated to grant every citizen the franchise." Who knows but that our Athens may produce a Socrates and a Solon whose disciples, inspired by a spirit not of mean utilitarianism but of an enlightened citizenship and statesmanship, may happily solve a problem greater than any Athens ever had to solve—our Native Question!

The Education of the Undergraduate.

Given such surroundings and such an atmosphere, it would be a perfectly sound argument to advance that the education of our Undergraduate would undergo, *sua sponte*, a radical and a particularly wholesome change. He would no longer be the help-less victim of Examination's wonderfully-ingenious machinery. Examinations would still exist, but in a perfectly normal and eminently rational form. Their work would be not to discover how much of knowledge our Undergraduate does not know that he may be ignominiously ploughed, but rather to discover the "inner man" behind the mask which he usually dons when up against the Opposition; and his final position would be determined not by his facility in "gaining marks," but by the amount of intelligence he owns, and by his value *in terms of character* as an asset of the community. We make bold to say that there is a mine of intelligence in our South African youth, whose rich veins we discover only when we detach him from the Examination syllabus, and a mine of character which only needs to be touched by some lofty ideal to prove him equal to his burden.

Given such surroundings and such an atmosphere, the education of our Undergraduate would be marked by *a wider Culture*—a Culture which the multiplicity of his Examinations at present tends to stifle. What is this "Culture"? Is it a true aim in Education? If so, how is it to be attained? The term Culture is often subjected to much contempt. It is regarded by strong men, who rejoice in their crudities, as a sign of effeminacy. It is held by many to be a thing apart from Character. There can be no greater mistake. The cultured man is often a stronger man than he whose physical courage has made him famous, inasmuch as his moral courage is of a higher development. This culture we regard as the fine flower of all Education; it is the result of the full development and the just balance of a man's higher powers. How, then, is it to be attained? It is not attained through "hard-reading" and studious isolation alone; it is not attained through hard cramming for University degree, for an ounce of honest thought is worth a ton of "cram." It is attained rather through constant association with those who are greater and wiser than ourselves, through interchange of ideas, through working up from bed-rock principles in all our thinking, through getting wisdom in our understanding, and through following a high line of conduct in all we do. To-day our Undergraduate has no time to think.

Patriotism.

Given such surroundings and such an atmosphere the Education of our Undergraduate would be hall-marked by a lofty Patriotism—a collective patriotism which would be a force impelling him to do great things; a patriotism which would stir the National spirit to a true understanding of its National work, and which would sink the interests of the individual in the needs of the Race. Such was the patriotism of Rome. This patriotism inspired her in her serenest hour of peace; but its fires never burned more steadily and brightly than when the clouds of National disaster lowered upon her people. It was in such an hour that the cry "Pro Patria!" rang through the land like a clarion-call, and her sons sprang with joy. They went to the wars; they returned with their brows bound with oak. But these magnificent triumphs of War were not the crowning glory of Roman patriotism; her victories of Peace were still more renowned. Her eagles were not more symbolical of conquest than they were of justice, law and administrative development. Such patriotism should be an inspiration to our Undergraduate, for there exists a striking analogy between the work he has to do and the work the Roman did. Now, there is no one who would deny that our Undergraduate is a lover of his country, and is ready to lay down his life when his country calls him. The occasion is rare when his country calls him to lay down his life, but his country daily, hourly, calls upon him to do a patriot's work. "Patriot" and "Jingo" are not synonymous terms. The work of the patriot is not to dominate the subject race at the point of the sword, even though we admit he should be a master of that sword. The patriot is he who has a just recognition of his duties towards his own and the subject races; who consecrates in his land a justice that never swerves from the path of justice; who is moved by no false notions of sentiment or of charity; who tempers his strength with mercy; who rejoices in his pride of Race, and who sets his fellow-men a noble example of how to live and a nobler example of how to die.

The National Work of the Undergraduate.

A. Education.—To what branches of National work should our Undergraduate devote his energies? Where best may he concentrate his powers? There are two spheres of outstanding importance, neither of which at present is seriously considered by him:—

1. Education. 2. Native Administration. Let us first offer a few reflections upon Education as a profession; ask the youthful Undergraduate his opinion as to the choice of a profession; ask the man in the street. They both unhesitatingly reply: "Where there is most money." It is a time-worn reply, but honoured by custom. "The Mines, the Bar, the Farm—these offer us most money. But Education—no use to us; leave that to our women-folk." What is the old South African tradition? Any discharged soldier or sailor, drunken or otherwise, provided that he could both read and write, possessed the necessary academic credentials to instruct the sons of Africa. Is the tradition yet dead? We saw recently in the *Cape Times* an advertisement inviting applications for the Principalship of a school at the munificent salary of Thirty-six pounds sterling per annum; board and lodging to be obtained for Eighteen pounds per annum. Here was an attractive position for a prospective Head who was wont to enjoy rare intervals of lucidity. Now in this vital matter of Education there are three phenomena we must recognise:—

(i) There are many thousands of white children in South Africa who are receiving not even the rudiments of an Elementary Education.

(ii) There are two hundred thousand Native and Coloured children on the School Registers of South Africa, and they are keen at least upon learning to read—and the Native press is growing daily more and more vigorous.

(iii) Eighty per cent. of our White children leave school after passing Standard IV.

When we calmly consider these facts, then we say that forces are at work which will have a telling effect before many years have passed. We must not forget that the Native press appeals to a mind by nature prone to holding indabas, whose theme will be, and is, the Rights of Man. Their writers will effect a revolution not by an appeal to the sword but by constitutional measures and by sheer force of economic pressure. "A wild dream," say some. But not so wild or so distant as it seems.

Why is it that our young South African of ability leaves Education as a profession severely alone? "Education," exclaimed a Professor, "is the Cinderella of all professions." The Professor is wrong. Education is no Cinderella in Germany or in Scotland. It is a Cinderella only in those countries whose men are blind to big issues. It is a Cinderella in South Africa. The South African Undergraduate has a rare opportunity of lifting South African Education from its present position of impecunious respectability to a social, and incidentally a financial, status that will attract the able sons of our able men to devote themselves to its cause. And if, as we have shown, there be a country that stands in need of such devotion, such discipleship, South Africa is that country. "Had I ten sons," said Mr. David Naudé, "of whom each wished to be a teacher, I would give them all with both hands." The old gentleman was wise. He foresaw what most of his brethren have failed to see. He foresaw that Education alone, based upon South African needs and inspired by South African ideals, was the only means to solve our National problems. South Africa should regard the Education of her sons as the soundest investment of her capital, and not hold "so noble a profession, so sorry a trade" in so melancholy a position that it is regarded as the last resource of the son with brains and the first resource of the fool of the family.

B. Native Administration.—The part our Undergraduate has to play in the administration of Native affairs has received no consideration from our University or Ministerial authorities. The fact that South Africa looks among the rising generation for the future rulers of her Native Races is not yet understood. There exists, apparently, no correlation between University work and preparation for Native administration: at least we have no specific University course, no professional Chairs of Native Languages, no National Schools of Administration where our young aspirants, if they yet exist, may be instructed and disciplined, and where they can obtain even rudimentary notions of what they have to do. Are we surprised then that amid such indifference in high quarters our Undergraduate has given this, the first of South African fields, no serious attention? Are we surprised then that he still holds the idea that the White Man is one creation, the Native another, and that each moves and has his being in a different sphere, as though they were not inhabitants of one and the same country, and as though their interests were not inter-dependent? We must detach him from this very superior attitude and get him to see things in their true proportion. It was the attitude of the French Aristocrats that sent them in 1789 either to the guillotine or into exile. The French nobles had failed in their National duties; our Undergraduate must not fail in his. We must give him practical assistance. How? We have urged the need of establishing colleges right in the heart of our Native Territories where, as part of his University course, our young administrator—to be—can be sent for some three months per annum to study the man on the spot—to master his language, to watch his ways, to get some understanding of how his mind works. The practical value of such an early training cannot be over-estimated. One of our distinguished Native Administrators, whose knowledge of Native Affairs is unrivalled, went through the course we have suggested. Whenever he is asked to what he owes his success in Native Administration, he answers: "To my knowledge of the Native gained in my boyhood on the benches of Lovedale."

Apart from the study, *in vestigio*, of the Native and his language it is outside the scope of this paper to suggest the lines the training of our young consul should follow. But if the aim of all our Administration be to lay down in the Native Territories the principles of constitutional government, even in the Village Council, and to foster first and foremost all agricultural and pastoral industries, the lines of his studies become manifest. Let us guard against the grave mistake of zealously attempting to graft all at once the advantages of a twentieth-century civilisation upon the Native. We are too apt to forget that the forces of natural evolution move slowly, and that any attempt to hurry Nature's laws can only be attended with disaster.

In Conclusion.

We are a young Nation; let us rejoice in our youth. Let us not forget that the history of the Undergraduate is the history of the Race. There is no Undergraduate who is not blessed with rich potentialities for good, and who at the same time has not inherited some latent tendencies to evil. He is but human. If good were as untiring in its activties as the forces for evil are sleepless, all would be well. We who are cognisant of evil, who have seen again and again a youngster, innately noble, rotted through evil communications ere he knew they were evil, must not only warn him, but must open up to him lines of thought and conduct that will allure him to put forth his finest efforts. He must know from the beginning that South Africa is a greater than he; he must spring with joy at the ennobling thought of "Pro Patria!"; he must rejoice in the pride of his Race and in their imperial lot; he must learn from the beginning that any society that is not founded upon the great rocks of truth, justice, simplicity, and duty—from which alone spring the streams of national greatness—is doomed to extinction; that the making of money is not the be-all and end-all of his work; and that only a lofty patriotism justifies his existence as a South African citizen. If we inspire him thus, and if he be destined to go out, he will go out all white, as the last Roman centurion on the last Roman wall went out all Roman, when confronted with the hordes of barbarism. There were a dozen javelins in that centurion—but they were all in front.

Our Undergraduate will not have lived in vain.

Preservation of Timber.—A new process of preserving timber has been devised in which the preservative consists of melted paraffin containing silica in suspension, with a small quantity of naphthalene. The silica is added in the form of a fine diatomaceous earth, and timber, regardless of its dimensions, may be permeated to the centre in four hours. The treatment is said to add resilience to the timber, and to render it immune to the attacks of marine borers, as a consequence of the hardness of the silica. It is also said that spikes and nails hold better in timber preserved by this process than in ordinary creosoted timber, and moreover remain free from rust. Wood treated by this process is claimed to be efficiently protected against waterlogging under all conditions.

Hydrolysis of Sugar by Ultra-violet rays.—Berthelot and Gaudechon have lately found that maltose and saccharose are reduced to glucose and levulose by ultra-violet rays exactly as they are by diastases. More recently investigations with respect to the conversion of other sugars have been reported in *Comptes Rendus*, and in all cases the action of ultra-violet rays was found to be similar to that of enzymes, so that results identical with those of digestion may be brought about *in vitro* under conditions which are perfectly aseptic, and alimentary liquids may be artificially digested by submitting them to the action of ultra-violet rays.

IS SILICA AN INDISPENSABLE CONSTITUENT OF PLANT FOOD?

By Marshall Lundie.

The use of farmyard manure as a fertiliser was known to man long before letters existed by which it could be recorded. We begin to get records of some agricultural practices in Roman times. Even then not only the value of dung was known, but also the virtues of other manures such as marl were established. The great poet Virgil in his works makes reference to the fertilising effect of a crop of vetches or lupins upon the succeeding wheat crop. To whatever point the knowledge of manuring had reached in the time of the Romans, for a long time it made no progress. In the mediæval times agriculture took a step forward; the value of chalk, woollen rags, ashes was generally known. The experience of men of an enquiring turn of mind had built up a certain knowledge of manures and manuring, and had even begun to reason a little on the mode of action of these manures. In spite of the experience that was accumulating respecting the fertilising value of this or that substance, no real progress was made towards a theory of manuring until the beginning of the nineteenth century.

Before the development of the science of chemistry it was naturally impossible to form any idea as to how a plant came to grow; while the nature of the plant itself, of the air, water and earth were equally unknown, no correct opinion could be reached as to how the latter gave rise to the former.

The true theory of the nutrition of plants begins soon after the discovery of the composition of the air. Priestly observed that plants possessed the power of purifying air rendered defective by combustion or by the respiration of animals, and he having been the discoverer of oxygen, it was found that the gas which leaves gave off was oxygen.

It was further demonstrated that light was essential for the development of these phenomena, while the oxygen was proved to be derived from the carbonic acid taken up, and that the gain in weight of the plant was practically represented by the carbon combined with the elements of water forming chiefly starch and sugar.

Such great scientists as Sir H. Davy, de Saussure, and Liebig took this important subject in hand, but it is to the latter that we must attribute the chief impulse which agricultural chemistry has received, for he drove home to the minds, both of scientific men and of farmers, the true theory of plant nutrition. He laid down the general principle that the carbon compounds which constitute more than 95 per cent. of the dry substance of most plants are derived by the plants from the atmosphere, and that if the plant be supplied with the 2 per cent. or so of mineral constituents which are found in the ash, it will then draw upon the atmosphere for all the materials the crop ultimately contains. These views of Liebig, coming at a time when great interest was directed towards agriculture, and backed by his great scientific reputation, aroused instant and widespread attention, being the foundation both of practical experiment and scientific research.

The ashes of a large number of plants were analysed, and the natural conclusion was drawn that all these ash constituents found were essential to plant growth, and were of equal importance. In the majority of cases the percentage of silica in the ashes was found to be very high, even amounting to as much as 50 and 60 per cent.

From this it was generally thought that silica was one of the chief constituents of plant food, and experiments were made using sodium silicate as a fertiliser, and the following from A. D. Hall's "Fertilisers and Manures," page 271-272, will show how far people went in drawing conclusions.

"Silica is so large a constituent of the ash of many plants, particularly of the straw of cereals, that it was inevitably regarded as a necessary constituent of the food of such plants, and was naturally enough supposed to contribute to the stiffness of the straw. In his manure Liebig supplied the alkalies combined with silica, and when Way discovered that certain strata of the Upper Greensand, near Farnham, contained considerable quantities of silicates readily dissolved by acids, the rock was for a time extracted and ground up as manure for cereals."

Sir Humphrey Davy's theory regarding the part that silica played in the plant was that it gave the plant a certain firmness, but he overlooked the fact that the leaves of the grasses which do not help to support the plant contain much more silica than the stems, and hence his theory cannot be correct.

This fact is also clearly brought out on glancing at the results of the analysis of the ashes of wheat given below.

		No. 1.	No. 2.	No. 3.	Average.
Leaves	Moisture ..	9.49%	8.92%	11.82%	10.08%
	Ash	6.38%	7.53%	8.75%	7.55%
	Silica	1.088%	1.369%	1.18%	1.212%
		No 1.	No 2	No. 3.	Average.
Stems	Moisture ..	13.36%	10.47%	14.17%	12.66%
	Ash	7.20%	7.66%	7.27%	7.34%
	Silica	.46%	.143%	744%	.449%

At this time many exaggerated ideas were held as to the the ammonia present in the atmosphere; the rain was believed to bring down as much as 30-40 lbs. per acre per annum of combined nitrogen instead of the 3-4 lbs. which we now know to represent the true quantity. This was due to imperfect methods of analysis. A great deal of controversy took place, some holding that it was unnecessary to use nitrogenous manures, as sufficient nitrogen as ammonia in the rain was supplied for the requirements of the plant.

The necessity of a supply of combined nitrogen was demonstrated experimentally, the yield being in fact roughly proportioned to the amount of combined nitrogen added as manure. If only the mineral constituents of the ash were supplied, the crop fell away rapidly as soon as the reserves of active nitrogen in the soil had become exhausted, and it was further demonstrated that the ordinary plants were incapable of utilising the full nitrogen of the air, but only took up nitrogen in a combined form from the soil as manure.

In addition to establishing the value of nitrogenous manures experiments also settled in a practical fashion the question of which of the ash constituents were indispensable to the plant and were necessary constituents of a complete manure.

The fundamental necessity of phosphoric acid and potash, and the non-essential nature of soda, magnesia, and silica as manure constituents were soon established. The synthetical method of determining the character of the plant food was carried out first by Liebig by means of water cultures, with the result that the following nine substances were found to form the indispensable constituents of plant food, *viz.*:—

Acidic.	Neutral.	Basic.
Sulphur trioxide	Water	Potassic oxide
Phosphorus pentoxide		Magnesic oxide
Nitrogen pentoxide		Calcic oxide
Carbon dioxide		Ferric oxide.

He further proved that each constituent of plant food performs certain definite functions in the system of the plant, which cannot be performed by the other constituents.

It was at this time that Liebig enunciated the great Law of the Minimum, which states that if one of the necessary ingredients of plant food is provided in insufficient quantities the plant takes up of the other necessary constituents only so much as is in a definite proportion to the quantity which is supplied in the minimum amount.

From these results it was clearly shown that silica, sodium and chlorine were not indispensable, although it is a well established fact that barley, figs and buckwheat thrive on a brack soil.

The author has carried out a series of water culture experiments with wheat, in order to demonstrate the non-essential nature of silica.

The experiment was carried out in the following manner:—A number of wheat grains were soaked overnight, then put into a germinating dish—Professor Nobbe's apparatus—on May 31st, 1911. It was observed on June 3rd that they had commenced to germinate. Three of the most healthy were selected for the experiment. Numbers 1 and 2 were put into the water culture solution on June 8th, while number 3 was put in on the following day.

The water culture solution was made up as follows:—

In 1 litre of distilled water was dissolved

1	gramme	of	Calcic Nitrate
.25	"	"	Potassic Nitrate
.25	"	"	Magnesic Sulphate
.25	"	"	Dihydric Potassic Phosphate
.25	"	"	Ferric Phosphate.

By kind permission of Dr. Hahn these experiments were carried out in his greenhouse, where the plants were safely protected from the strong winds. On calm days they were put outside and exposed to the direct rays of sunlight.

The rate at which these young plants grew in the solution was very striking, no indication being given that they were sacrificing their health for height. It may be interesting here to give the measurements of these young plants during the first few days of growth in the water culture solution to illustrate this rapid growth.

	June 12th.	13th.	14th.	15th.	16th.	17th.	23rd.
No. 1	$4\frac{3}{4}''$	$5\frac{1}{2}''$	$6\frac{1}{2}''$	$7\frac{1}{2}''$	$8\frac{1}{2}''$	$8\frac{3}{4}''$	$12\frac{1}{2}''$
No. 2	$4\frac{1}{8}''$	$5''$	$6''$	$7\frac{1}{2}''$	$8''$	$8\frac{1}{4}''$	$12\frac{1}{4}''$
No. 3	$2\frac{1}{2}''$	$2\frac{3}{4}''$	$3\frac{1}{2}''$	$4\frac{3}{4}''$	$5\frac{1}{4}''$	$5\frac{3}{4}''$	$10''$

The solutions had to be filled up every day with distilled water, owing to the transpiration current through the plant of water which enters by the root hairs, and is eventually evaporated from the leaves and other growing surfaces of the plant. This amount became considerable when the plant became full grown. On a warm day as much as 500 c.c. was observed to be the decrease in volume of the culture solution. The solutions in which the young plants were growing were frequently shaken up so that more air, and hence oxygen could be dissolved.

On July 12th, August 26th, September 9th, September 29th, October 12th, fresh water culture solution was put in. These growing plants were carefully watched, and if at any time a fungus was noticed on the cork or cotton wool these would be immediately replaced by fresh sterilized material.

The height to which these plants grew and the enormous number of stems and leaves produced in each case were very striking; in fact they looked more like bushes, and gave one the impression that they were making full use of the food material supplied, and were not sparing themselves in any way.

The plants, having come to perfection, were on October 20th removed from the solutions and hung up to dry. The heights they attained were as follows:—

	Height.	No. of Ears of Corn.
No. 1	4 ft. 9½ inches	24
No. 2	4 „ 7½ „	16
No. 3	4 „ 2½ „	24

When they were perfectly dry the stems and leaves of each were separately cut up and analysed as to the percentage of moisture, ash, and silica.

The total weight of dry straw (leaves and stems) were as follows:—

	Leaves.	Stems.	Total.
No. 1	25.430 gms	20.130 grammes	45.550 grammes
No. 2	25.986 „	18.049 „	44.035 „
No. 3	25.773 „	16.592 „	42.365 „

The average weight of one grain of wheat was found to be .0447 grammes, and this had increased on an average to 43.983 grammes, excluding the weight of the roots and ears, which would have raised this figure still further.

The results of the analyses were as follows:—

		No. 1.	No. 2.	No 3.	Average.
Leaves	Moisture ..	9.49%	8.92%	11.82%	10.08%
	Ash	6.38%	7.53%	8.75%	7.55%
	Silica	1.088%	1.369%	1.18%	1.212%
		No. 1.	No. ?.	No. 3.	Average.
Stems	Moisture ..	13.36%	10.47%	14.17%	12.66%
	Ash	7.20%	7.66%	7.27%	7.34%
	Silica	.46%	.143%	.744%	.449%

Silica as it exists in sand and in rocks is virtually insoluble in pure water. It may be, as some botanists suppose, that plants exude from their root hairs some acid liquid which can extract and dissolve silica from rocky materials in the soil, and thus render it available for plant food.

We will now contrast this low percentage of silica in the leaves and stems of wheat grown in water culture solution with that of some crops grown on soil:—

Grasses.	Silica.	Straw.	Silica.
Meadow Hay (1st cut)	28.8%	Wheat Straw	67.6%
Sweet Grasses	36.5%	Summer „	47.6%
Sour „	33.2%	Bran	71.7%
Winter Wheat (Young Plants)	42.2%	Winter Rye	56.3%
		Summer „	54.1%
Oats (Young Plants)	27.6%	Barley	52.0%
Maize (Flowering Plant)	18.3%	Oats	46.7%

How different the demands for silica are in other crops may be shown by these figures:

Buckwheat	5.5%	Silica.
Peas	6.8%	„
Beans	7.3%	„

Some of the seeds of these water cultures were put in a germinating dish, and after a few days were observed to germinate.

We have now completed the life cycle of one of these wheat plants, and have shown the non-essential part silica plays as a nutritive.

The silica is deposited in the cell membrane and being in the epidermis of the plant, supplies a certain protection from fungi (rust) sending its mycelium roots into the leaf.

I have it on Dr. Hahn's authority that a number of years ago a series of water culture experiments were being carried out at the South African College Chemical Laboratory, when they became attacked by rust, and in two days every plant was overrun with the fungus. This clearly shows that when the plant is deprived of its silica it can offer no resistance to the ravages of such pests as rust.

Here in South Africa we have a fine sunny climate where everything thrives well, including the pests.

As to how and to what extent silica in a plant repels the attacks of fungoid growth is indeed a subject offering a wide field for research, and being of such great importance to us South Africans, surely this matter should be taken up and thoroughly investigated by our biologists.

It is well known that the silica in soils derived from granitic rocks is less soluble than the silica which is derived from doleritic and basaltic rocks. In the granitic rocks the silica exists as pure quartz, and as trisilicate in felspar and mica, whereas dolerite and basalt do not contain free quartz, and their constituent silicates like hornblende, augite, anorthite, are disilicates and monosilicates.

Since the silica in the granitic soils is less soluble than silica in the dolerite and basaltic soils, one cannot help thinking that the cereals which are such great silica eaters will take advantage of this when grown on doleritic or basaltic soils, and will contain more silica in the ashes than the cereals grown on granitic soils. If the theory is correct that the presence of silica in the cereals renders the plants more resisting to the attacks of fungoid growth, the cereals grown on dolerite and basaltic soils should suffer less than the cereals grown on granitic soils, provided that climatic and weather conditions are the same.

These are questions of such economic importance to South Africa that they should receive full attention at the hands of those who are carrying on research in connection with the production of cereals in our country.

ON THE EFFECTS OF THE BITE OF CERTAIN OPISTHOGLYPHOUS SNAKES.

By W. Horner Andrews, M.R.C.V.S.

In the Catalogue of Snakes of the British Museum, Boulenger divides the order Ophidia into five families, of which only two, the Colubridæ and Viperidæ, are of special interest to the pathologist.

The members of the family Colubridæ are arranged, according to certain notable differences in their dentition, in three divisions, *viz.*, the aglypha, opisthoglypha and proteroglypha.

In the aglyphous Colubridæ the upper jaw bears a considerable number of teeth arranged in two series, maxillary and palatine; the various genera show some variation in the number and disposition of these teeth, but the latter are all solid.

In the proteroglyphous Colubridæ the palatine teeth are more or less similar to those of the aglypha, although generally fewer in number; the maxillary teeth, on the other hand, show a striking difference.

The series of more or less small maxillary teeth shown in the aglypha is here represented, on each side, by a single large tooth or fang, situated towards the anterior extremity of the maxilla, and, immediately behind this fang, a number of accessory or replacing fangs in different stakes of development.

The largest fang is more or less deeply grooved, and the base of this groove is in communication with a duct leading from a highly specialised poison-gland.

The accessory fangs have a similar structure, but are generally more or less rudimentary, and covered by the membranous sheath of the principal fang; occasionally one or two of these teeth may approach the size of the principal fang, and penetrate into any object bitten by the snake.

The opisthoglypha are, morphologically, intermediate between the two divisions described. In them the maxillary teeth may be reduced in number, but there are always some solid teeth, similar to those found in the aglypha.

Towards the posterior extremity of the maxilla, however, are a small number of somewhat larger teeth possessing a distinct groove. This groove does not communicate with any large and highly specialised duct and poison gland, as in the proteroglyphous snakes, but a glandular structure is situated in close proximity to the base of these grooved teeth.

Finally, the family Viperidæ, which presents some striking modifications in the maxillæ and adjacent bones, is characterised by the possession of one very large maxillary fang, pierced by a more or less completely closed channel which communicates with a duct leading from a well-developed poison gland; there are also accessory fangs.

With regard to the pathological effects produced by the bites of snakes, many ages have passed since primitive man learned from experience to recognise certain well-differentiated kinds of snakes as highly venomous.

The difficulty for the uninformed of differentiating between many genera and species, together with the serious results consequent upon errors in this respect, has, however, led to the development of a feeling of horror and repulsion which is, with some notable exceptions, more or less general among the human race, and the majority of human beings are wont to regard all snakes as dangerous enemies.

The growth of zoological science, with the introduction of systematic classification, soon led herpetologists to recognise that the proteroglyphous Colubridæ, and the Viperidæ, are especially adapted for the infliction of venomous bites, and that such a feat is impossible to the solid-toothed colubrine.

In the opisthoglyphous snakes they recognised the existence of an earlier stage in the development of a specialised poison-gland, and of the modified dentition necessary to facilitate the introduction of the secreted venom into the tissues of the prey attacked.

They have considered, however (unanimously, I think), that these snakes are unable to inflict a bite of such a character as seriously to endanger the life of man or of the larger mammals.

Thus Calmette, in his classical work on venoms, writes:—

> Presque tous les serpents classés dans ces trois sous-familles [*i.e.*, the three sub-families of the opisthoglypha] sont venimeux, mais à un faible degré. *Ils ne sont pas dangereux pour l'homme.* Leur venin ne fait que paralyser leurs proies avant la déglutition: il ne constitue pas pour eux un moyen efficace de défense ou d'attaque.

And again, in speaking of the sub-family Dipsodomorphinæ, he remarks:—

> Aucun de ces reptiles n'est susceptible d'occasionner d'accidents sérieux chez l'homme, à cause de la disposition particulièrement defectueuse de leur appareil venimeux.

Popular opinion in South Africa has generally ascribed venomous powers to certain opisthoglyphous snakes, and particularly to the boomslang and the schaapstekers, and there have been more or less circumstantial reports of serious illness, and even death, occurring in man as a result of a boomslang bite.

In view of the unreliability of popular evidence, frequently distorted and obscured by incomplete observation and prejudice (the latter especially in any matter relating to snakes), these reports attracted but little notice.

In recent years Mr. Fitz Simons has recorded the case occurring in the Port Elizabeth Museum, where Mr. Williams nearly lost his life as the result of a bite from a boomslang, and Mr. Fitz Simons performed a number of experiments on fowls and small animals, showing that the bite of the boomslang was undoubtedly fatal to such animals.

The case of Mr. Williams, however, stood alone, and lacked the confirmation which would be afforded by the production of similar symptoms in the larger mammals, and in animals more closely allied to man. It might, therefore, be considered to be a mere coincidence, or as a case of some septic infection of the wound inflicted.

In the year 1911, Dr. Theiler suggested that I should take up the study of the symptoms and lesions produced in the various domesticated animals by the venoms of the commoner South African snakes, and during the course of this work I was enabled to investigate more fully the question of the ability of the boomslang to inflict a bite dangerous to the larger mammals, and, inferentially, to man.

This investigation was afterwards extended to certain other opisthoglyphous snakes, and the experiments, although at present incomplete, have yielded a number of interesting results.

In the first place, it was decided to allow the snake which was being tested actually to bite the experimental animals, and this method was chosen as reproducing, as far as possible, natural conditions with regard to the dose of the venom employed, and the method of its introduction into the animal tissues.

This was of particular importance in dealing with the opisthoglypha, on account of the relatively small size of the poison gland, and of the peculiar dentition.

The injection of known quantities of dried venom, on the other hand, should, in future experiments, yield valuable information with regard to the minimum lethal dose, and must be utilised for the more detailed study of the effects produced on particular systems, organs, and tissues.

For manipulating large snakes, such as boomslangs, we generally employ a pole about six feet in length, fixed near one end by two holes, about one inch apart. A stout cord, knotted at one end, is passed through the two holes, and the snake is held, a few inches behind the head, in the loop thus formed.

The further end of the pole, together with the loose unknotted end of the cord, may be held in one hand, and with the other hand it is advisable to secure the tail of the snake.

Smaller snakes, such as schaapstekers, are more easily held with forceps, or with the hand, but mechanical means are generally to be preferred for our purpose, as it is then possible to allow the snake greater freedom to strike.

The snake, secured by one of the above-described methods, was brought into contact with a selected region of the experimental subject, and allowed to bite freely; in some cases it was necessary to irritate the snake before any attempt to bite was made.

The bitten animal was then placed in a loose box and freed as far as possible from all restraint, and the clinical symptoms exhibited were noted at short intervals.

There are some twenty-two species of Opisthoglypha recorded as having been found in South Africa, and of these we were able to make observations on the following:—

1. *Dispholidus typus*, the boomslang.
2. *Trimerorhinus rhombeatus*, the rhombic schaapsteker.
3. *Trimerorhinus tritaeniatus*, the striped schaapsteker.
4. *Leptodira hotambaeia*, the herald or red-lipped snake.
5. *Psammophis furcatus*, a sand snake.
6. *Tarbophis semiannulatus*, the tiger snake.

The following is an account of the number of animals bitten in each case, and the results of such bites:—

Animals bitten by—

1. *Dispholidus typus,* the boomslang.

(a) One baboon which recovered from one bite, after exhibiting symptoms of serious illness, but which died as a result of a second bite, inflicted after an interval of twenty-five days.

(b) Two horses. One horse died, but the other showed only some degree of dullness, which rapidly passed off. In the latter case the snake used was exceptionally fierce and aggressive. and was found to have broken off the fangs on one side, as a result of biting fiercely at the stick employed in its capture.

(c) One mule, which died.

(d) Five sheep, of which three died.

One of the other two sheep was bitten by the snake with the broken fangs, alluded to above, and no symptoms were shown.

The other sheep which failed to show the usual symptoms, was bitten by a snake immediately after the latter had inflicted what proved to be a fatal bite on another sheep.

Thus in ten experiments there were six deaths, one recovery, and three cases in which, probably for the reasons above-mentioned, the snake failed to introduce any significant amount of venom into the subject of the experiment.

With regard to the *clinical symptoms* produced, the general nature of the lesions, and of the symptoms arising therefrom, was the same in all cases, but there was, of course, considerable variation in minor points.

In order to convey an accurate idea of the chief clinical features observed, I propose here to quote at some length from my records of two cases.

1. *A young female adult baboon.*

This baboon was bitten on the right shoulder by a female boomslang at midday, 29th December, 1911; the snake bit well, and retained its hold for nearly two minutes.

During the operation the baboon showed signs of great fear, uttering shrill cries and making frenzied efforts to escape.

For five minutes, after the bite, the baboon was restless and frightened, but after a short time it became quieter, and it was soon eating, drinking, and playing happily.

Blood was slowly oozing from the punctures made by the fangs, and the baboon occasionally felt the wound with the left hand, then smelling and tasting the finger tips with some appearance of anxiety, which was, however, very transitory.

At 5 p.m. there was a noticeable hard, but not painful, swelling at the site of the bite, and at 10 p.m. this swelling was rather larger. Blood was still oozing from the punctures, but the general health was, apparently, unimpaired.

The following morning the swelling was found to have increased in size, and to have extended over the shoulder and down the arm as far as the elbow.

The baboon had apparently been lacerating its wound with its nails; blood was still oozing from the wound, and the appearance of the floor, which was much bespattered with large drops of blood, showed that this process must have occurred fairly freely during the night.

The animal was somewhat depressed, but fairly active.

At noon the baboon was distinctly dull and depressed, and occasionally examined and felt the wound, which was still bleeding slightly.

At 5 p.m. it was dull and depressed, and was lying down, but it was still able to rise and walk about, and was fully conscious. Much thirst was shown. Slight bleeding from the wound continued.

On the 31st of December, the second day after the bite, the baboon was found lying on its side, and was very dull and sleepy, but occasionally rose and walked a little. It was quite conscious of its surroundings, and at intervals it bit idly at various articles, but would neither eat nor drink.

During the greater part of the day the baboon was lying quietly on the left side, occasionally kicking with the right leg, and touching the head and the region of the bite with the hand.

At 4 p.m. it appeared to be somewhat better, and attempted to drink water and eat fruit, but after eating eagerly for a few minutes, it would become languid and finally stop, remaining motionless for some minutes, during which it appeared partially to have lost consciousness.

On some occasions this stage of semi-consciousness occurred when the hand, clutching some fruit, had been raised half-way to the mouth, and it then remained in this position for several minutes.

Finally, the animal would appear to waken, and it would then continue to eat.

If lifted to its feet, the baboon would walk a few steps, and would then sink down and lie on the side or back, as if fatigued.

The following day, the 1st of January, 1912, the baboon was rather stronger, and occasionally rose and walked, but it soon became fatigued, and relapsed into the recumbent position; it was eating and drinking more readily.

There was a livid discoloration of the skin over the right shoulder and arm (on both the outer and inner aspects), descending almost to the elbow, and extending from one to two inches on to the breast.

During the next two days the baboon rapidly regained its strength, the wound dried up, and the swelling disappeared, and on the 4th January, six days after the bite, the animal appeared to be quite normal.

There were no signs of any sickness until the 23rd of January, when the experiment was repeated, with the following result:—

23rd January.—Bitten in the abdominal wall by a female boomslang at 12.33 p.m. The snake bit very well, and retained its hold for three and a half minutes.

At 4 p.m. there was a distinct swelling around the bite, but no general symptoms of disturbance.

During the evening the swelling increased very considerably in size, and the baboon became dull and distressed, moving very languidly. At 11 p.m. the conjunctival and buccal mucous membranes were noticeably paler than normal.

The following morning the baboon was found lying on its side, with the eyes closed, and apparently very weak.

If manipulated it would slowly open the eyes and grunt, but soon relapsed into a semi-comatose condition. It refused fooa, but occasionally sat up and drank a little water.

There was a diffuse swelling over the abdomen, and one could observe a large livid patch of skin around the bite, and two other livid areas extending anterior to this. There was also one small livid area in the right axilla.

At 11 a.m. the baboon was comatose, the extremities were cold, the mucous membranes almost white, and the respiration very slow, irregular, and sighing.

At noon death was found to have occurred, almost 24 hours after the bite.

Post-Mortem.—The most remarkable features were:—

1. Hæmorrhagic infiltration of the subcutaneous tissue over more or less well-defined areas, both at the side of the bite and in adjacent parts, and in regions such as the axilla and sternum, quite remote from the bite.

2. Some small hæmorrhages into the cæcum and colon.

3. General pallor of other parts, due to extensive hæmorrhage.

The histological changes in different organs have not yet been worked out.

2. *Sheep No.* 2632.

Bitten on the right thigh four times, by a female boomslang at 1 p.m. on the 23rd January, 1912.

2 p.m.—Slightly lame on the right hind leg.

No further change was noted during the evening up to midnight.

On the following morning the sheep was found to be down and unable to rise. Respiration very hurried. There was no noticeable swelling, but a livid area around the bite.

During the day the sheep became progressively weaker, and the respirations, which were at first very deep and frequent, became less frequent, but deeper and spasmodic.

At 2 p.m. the mucous membranes appeared rather pale, and the respiration was stertorous, with some froth in the nostrils.

Death occurred at 3.20 p.m., about twenty-six hours after the bite.

Post-Mortem.—The most striking lesions were:—

1. Hæmorrhagic infiltration of the subcutaneous connective

tissue around the bite and over two small areas on the abdominal wall.

2. Froth in the trachea and bronchi, and some pulmonary œdema.

3. Liver parenchyma pale and soft, with some small hæmorrhagic areas.

4. Kidneys—numerous small hæmorrhages under the capsule and in the medulla, but particularly numerous in the cortex.

5. Petechiæ and hæmorrhagic streaks in the omasum, abomasum, and jejunum, and particularly in the cæcum and colon, the contents of which were deeply blood-stained.

In these and the other fatal cases observed by me, the most striking feature in the process is the long period which may elapse before the onset of symptoms, and the marked effect on vascular endothelium.

In no case did I see any symptoms pointing very clearly to the action of a potent neurotoxine; dullness, depression, and some evidence of local pain at the site of the bite, were the only nervous symptoms noted.

With regard to the action on the blood, the boomslang venom appears to exert some anti-coagulative, and slight hæmolytic action *in vivo*.

From clinical observation, it would appear that death occurs chiefly as a result of the exhaustion consequent upon extensive hæmorrhage, and it can no longer be seriously doubted that the boomslang is able to inflict a bite fatal to man and the larger domesticated animals, provided that the snake is able to secure a favourable hold.

Such a conclusion has a certain amount of practical importance, and is of great interest on theoretical grounds, but I do not think that boomslangs are likely to cause many deaths among human beings.

In the first place, the boomslang is generally (but not always) a very timid snake, and unlikely to bite a large animal unless actually seized or cornered.

In the second place, it is necessary, on account of the peculiar dentition, that the boomslang should have the opportunity of biting, to the full extent of the jaws, on a part without any protective covering of even moderate thickness, and that it should be able to retain this hold over a period of several minutes.

In fact, the opisthoglypha generally show quite a characteristic mode of biting, very notably different from that of the proteroglyphous snakes, and demanding much more favourable circumstances for its infliction than is the case with the latter.

2. *Trimerorhinus rhombeatus* and *tritæniatus*, the schaapstekers.

Repeated experiments on guinea-pigs and rabbits have shown that the schaapstekers are able to inflict a bite rapidly fatal to such animals, the time elapsing before death varying, in our experiments, from seven to forty minutes.

The symptoms are quite characteristic: after a period of quietude, the animal shows muscular tremors, usually beginning near the region bitten.

These tremors rapidly become general and increase both in their rate and intensity, until the whole animal is shaken by a rapid series of muscular contractions from head to foot.

These contractions gradually become weaker and less frequent until the animal falls over on its side, and, after occasional twitching, death supervenes.

I have been able to observe that these muscular contractions begin at a period when the animal is perfectly conscious of its surroundings, but during the course of these spasms the animal appears to lose consciousness.

It was very difficult to induce schaapstekers to bite larger animals, but in a few cases this was successfully performed.

Of two dogs, bitten by *T. tritæniatus*, one showed a local swelling with lameness, but the other showed no symptoms.

One sheep, bitten by *T. rhombeatus*, showed serious illness, and died about forty minutes after the bite.

There was a local swelling producing some lameness and hurried respiration, but the most striking feature was most profuse vomiting and prolonged and violent retching.

As this is the only fatal case recorded in a sheep, I do not bring it forward as a proof of the ability of the schaapsteker to inflict a bite fatal to sheep; this question must be settled by further experimentation.

In conclusion, I must record negative results in the considerable number of experiments which have been performed with *Heptodira hotamboeia*, the subjects chosen being rabbits and guinea-pigs.

Four similar experiments with *Psammophis furcatus*, and one experiment (on a guinea-pig) with *Tarbophis semiannulatus*, also gave negative results.

TRANSACTIONS OF SOCIETIES.

South African Institution of Engineers.—Saturday, January 11th: Mr. E. Farrar in the chair.—"The equipment and operation of a whaling station": W. **Pile.** A description of the works of the Premier Whaling Co.'s Station at Delagoa Bay, where whales up to 100 tons in weight are dealt with on a slipway 18 feet wide, of unusually heavy construction. The station comprises flensing platform, digester house, blubber house, boiler house, oil refinery, guano factory, guano store, cooperage, set-pot house, workshops, storage tanks, settling tanks, and drains to sea. All the buildings, except the quarters, are of steel structure, with concrete floors, and there is a concrete sea wall to reclaim certain areas and to provide storage for casks and drums ready for shipment. The factory is situated on an island six miles from the mainland, and is held to be one of the most up to date of its kind in the world.

Saturday, February 8th: Mr. J. A. Yule, President, in the chair.—"Notes on a bituminous producer gas engine plant": J. R. **Cowell.** Particulars were given regarding a suction gas plant which had been working in the Waterberg District on Transvaal bituminous coal. The plant had been designed with special reference to the conditions under which it was to work, *viz.*, continuous running, in a semi-tropical climate, at a high altitude, and with Transvaal coal, and it had undoubtedly fulfilled the requirements.

Friday, March 7th: J. A. Yule, President, in the chair.—"Centralised organisation at the Crown Mines, Ltd.": R. C. **Warriner.** The centralised organisation was the outcome of the amalgamation of seven separate mines. The main features of the equipment of each of these seven units were enumerated. The entire property now comprises 2,216 claims, covering an area of nearly three and a half by three miles. The general plan of centralisation was described, and details were given of some of the more important features. The effect of centralisation on costs was briefly discussed, and the theoretical saving, on a milling basis of 200,000 tons per month, was estimated at £294,000 per annum.

South African Society of Civil Engineers.—Wednesday, 12th March: F. E. Kanthack, M.I.C.E., President, in the chair.—"Presidential address": F. E. **Kanthack.** The address dealt with the prospects of the Civil Engineer, and more particularly of the private practitioner, in the Union of South Africa. It was difficult to determine the spheres of activity belonging respectively to the State and to the private engineer. State engineering in South Africa—which was the result of popular demand--would not diminish, but widen the activities of professional engineering. Speaking broadly, engineers in countries like South Africa would be either servants of the State or municipal engineers. There was much municipal work offering throughout the Union, which Government was driven to undertake when private engineers were not available. Irrigation boards were being formed throughout the Cape Province, controlling projects of considerable size: for these it was almost impossible to obtain competent engineers, and the demand for temporary surveyors and engineers in the Irrigation Department was increasing. For the non-specialist consulting engineer, however, there was but a small and unprofitable field, and it was a matter of highest importance that the qualifications of engineers in private practice should be raised.

Wednesday, 9th April: F. E. Kanthack, M.I.C.E., President, in the chair.—"The geology of underground water supply: " Dr. A. L. **Du Toit.** The author discussed in detail several factors governing the movements and characters of underground waters, more especially with reference to South Africa. In South Africa rocks of high or even moderate porosity were practically unrepresented: effective porosity was therefore dependent to a high degree upon cracks, joints and other planes of limited cohesion. Geographical environment caused great differences in the behaviour of any geological formation with respect to water supply, and several instances hereof were given. Springs originated mainly at the junction of two sets of dissimilar rocks. Thus a number of important springs derive their waters from the junction of the Table Mountain sandstone with the overlying slates of the Bokkeveld series. The effect of the doleritic intrusions which cut the Karroo into a number of more or less distinct compartments, and that of the dolomite of the Transvaal and the dolomitic limestones of Griqualand West on water supply was next discussed. The author proceeded to refer to the influence of geological formation on the chemical composition of sub-soil waters, in proof of which he directed attention to Dr. Juritz's discussion of the analytical results obtained from about 400 waters from various formations in the Cape Province. Circumstances affecting lateral and vertical variation in the salinity of waters were dealt with, and, after referring to the relation between the average yield of bore-holes in the Cape Province and their depth, and to the subject of artesian waters, the author concluded with a consideration of certain special areas in South Africa where, for geological reasons, or owing to their environment, difficulty had been experienced in tapping fair supplies of underground water.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, 15th March: W. R. Dowling, M.I.M.M., President, in the chair.—"Cyanide practice in India": H. M. **Leslie.** In India cyaniding has up to the present been practically confined to the Kolar Gold Field, on the mines of which the author was employed from 1894 to 1896 in erecting and starting new plant. The work accomplished during the subsequent seventeen years was outlined, and the gradual development of the cyanide process, from its first introduction there, to the present day, was described. —" The recovery of black sand and floating particles of metallic minerals": J. M. **Neill.** The author emphasised the desirability of extracting, collecting, and treating separately all the black sand, of which some happens to be on the amalgamated copper plates, and is at present collected rather incidentally. The sand consists mainly of iron sulphide, but contains a large quantity of gold, with small quantities of iridium, osmium, platinum and other metals of that group. Careful extraction and treatment of this valuable constituent of the ore leads to considerable gain in recovery, and suggestions were made for the treatment to be employed, in which connection a specially designed apparatus had been patented.

Royal Society of South Africa.—Wednesday, 19th March: Dr. L. Péringuey, D.Sc., F.E.S., F.Z.S., President, in the chair.—"The Antiquity of Man" (Presidential address): Dr. L. **Peringuey** The various stages of the production of artefacts in the shape of stone implements were briefly traced. The eoliths were then discussed in more detail, and the theory, that accidentally pointed or sharp edged flakes were the precursors of the later carefully trimmed amygdaloid tools, was examined. Attention was drawn to the fact that most South African lithic implements consisted of quartzite, indurated shale, quartz, or hard volcanic rocks, such as basalt. Believers in the authenticity of the so-called eoliths had to assume in support of their theory anthropomorphous apes or simian-like men, semi-human precursors to whose hypothetical existence, as an explanation of the oligocene flints, no one now pays much attention. The theory of the simian origin of Man was still being entertained by some antiquarians in 1894, when remains of an animal, to which Dubois gave the name of *Pithecanthropus*, or monkey-man, were unearthed in Java. The position of this animal in the scale of humanity is certainly not accepted by all competent men in the way that its discoverer wished, Virchow, in fact, affirming that the Java remains did not all originate from one individual, but that the skull was that of an ape, and the thigh-bone that of a man. In the Lower Tertiary (Oligocene) in Egypt what is apparently an anthropomorphic ape (*Propliopithecus*) has been found, but, unfortunately for those who hold to the theory of the artefact character of the oligocene flints, such an ancestor of Man could not have been physically able to chip flints, for its size scarcely exceeded that of a new-born infant, while even the *Anthropodus* of the Lower Pliocene must have been about the size of a twelve-year-old child. At Ipswich a skeleton has been discovered which is said to represent pre-Boulder clay Man, but on this point the statements made with regard thereto are not very reassuring. After describing the Neanderthal skeletons, and the splendidly worked implements which accompanied them, the author discussed the evidence afforded by the lithic industry of South Africa in connection with the antiquity of Man. No discoveries have hitherto been made to substantiate the presence in South Africa of a Man belonging to the Neanderthal race, but his tools were present in abundance. The presence of the amygdaloidal boucher contemporaneously in Europe, Asia, Africa, and America suggests migration, and the incredible number of these tools in South Africa suggests a population much more dense than that of the middle Palaeolithic of Europe. Evidence points to the evolution of the boucher in South or Central Africa, and therefore postulates for its maker a greater antiquity than that of the Neanderthal Man. In the Vaal River gravels, where molar teeth of the *Mastodon* have been found, there are also (at Windsorton) almost innumerable hand wedges, indicating the possibility that in South Africa Man was contemporaneous with the *Mastodon*, the greatest antiquity yet attributed to him, unless the *Mastodon* continued longer in South Africa than in Europe.

ANTARCTICA.

By Prof. E. J. Goddard, B.A., D.Sc.

(*Evening Discourse delivered in the Town Hall, Port Elizabeth, on Wednesday, July 3rd, 1912, and illustrated by lantern slides.*)

During the past ten years Antarctic explorers have achieved considerable success, and only recently we have heard that at last the goal has been reached by Captain Amundsen. We have also every reason to hope that the same measure of success has attended the efforts of Captain Scott, and that the latter will return* with a considerable amount of biological and geological material, the investigation of which will assist us in the elucidation of the problems of Antarctica and the continental masses of the Southern Hemisphere.

The question is often asked by the layman: What is the value of the work of Antarctic explorers? What is the justification for the money spent and the exposure to danger?

The main object in this popular discourse is to demonstrate the value of such work, and to point out why Antarctic problems fascinate the scientific world, and especially those scientists who devote their attention towards the elucidation of biological and geological problems in the Southern continental masses. Preliminarily, let us note that in the study of the distribution of animals and plants, living and extinct, naturalists have long regarded the continents of the Southern Hemisphere as having once been closely connected together and more intimately related to Antarctica. In fact, only by the assumption of such a continuous land area can distribution of the various forms from their centre of evolution be satisfactorily explained. It will be seen that the nature of such connections and the times during which they existed can only be satisfactorily known when the geology and biology of the various masses is critically examined with the assistance of fuller details than we yet possess in regard to the various land masses. However, in a broad way we have achieved much.

Antarctica of the present day is a huge continental—or, at least, potentially continental— mass, uninhabited by the terrestrial animals and plants with which we are familiar, devoid of the bird life found in other lands, and of the varied foliage characteristic of large areas—a huge ice-covered mass monotonously isolated in every way. That it has not always existed as such we are sure. We all realise that land and sea areas are continuously but gradually changing, and that no part of the earth's crust can be truly regarded as constant in form and area, subsidence taking place here, upheaval being the order of the day there; that meteorological conditions are inconstant, and climate is changing even within our own recollections; and that the

* It will be remembered that intelligence of the tragic termination of the Scott Expedition in March, 1912, was not received until seven months after the delivery of this lecture.

history of the past, as revealed to us by the geologist, shows us that vast climatic changes have taken place.

Although the exact limits of this huge mass are not yet known, we can assert that it is a continental area larger than Australia, with an average elevation of about 6,000 feet. It is composed of igneous and sedimentary rocks, which rise into high mountains and huge plateaux, the South Pole being situated at a height of about 10,000 feet. Other than marine life and avian forms such as Penguins, the only existing representatives of animal and vegetable life are lowly forms such as Rotifers, Protozoa, Mosses, Algæ, and Fungi. The absence of higher forms is readily explained by the extreme nature of the climate.

That this is so is proved by the existence in the past of Ferns and Conifers, etc. In Jurassic times there existed in Graham's Land, now covered with ice and snow, Ferns, Cycads and Conifers, and it is interesting to note in the table below that the same forms once existed in India and the Southern Continents.

	Antarctica.	South Africa.	India.	Argentine.	Australia.
Sagenopteris	×	—	×	—	×
Thinnfeldia	×	×	×	×	×
Cladophlebis	×	×	×	—	×
Pterophyllum	×	—	×	×	×
Otozamites	×	—	×	—	×

The significance of this distribution we will discuss later, but it will be noted here that the evidence of these plants proves that in Jurassic times Antarctica enjoyed a much more equable climate than at present.

Again, at no considerable distance from the South Pole itself, Lieutenant Shackleton's party discovered seams of coal, and returned with a comparatively well-preserved specimen of a fossil Conifer. This was obtained in the Beacon Sandstone, which constitutes such an important feature in the geology of part of Antarctica. The age of this formation is not definitely known, but it is certainly Palæozoic.

This indicates that in Palæozoic times a more equable climate favoured Antarctica.

The occurrence of fossil conifers and beeches, etc., in Seymour Island is proof that, during the time in which the Tertiary rocks of that part were being deposited, the milder conditions which obtained in Jurassic times were continued.

Now, it is well known that many parts of the earth have, during various periods of the past, been subjected to much colder conditions than now obtain. For example, Australia has been subjected to glaciations at least three times: namely, during Cambrian, Permo-Carboniferous, and Pleistocene times. South Africa, India, and South America have likewise been subjected to glacial conditions, the Dwyka conglomerate, which stretches beneath and forms the margin of our Karroo, being a deposit formed by the action of Permo-Carboniferous ice-sheets.

Attempts have been made to explain these ice-ages on such grounds as:—

(1) Changes in the amount of carbon dioxide in the atmosphere.

(2) Shifting of the Poles.

(3) Amount of heat received from the sun.

(4) Distribution of land and sea.

(5) Existence of high land areas, etc., etc.,

None of these theories can be regarded as proved. The effect of these glaciations must have been very serious on the distribution of living forms, and must needs compel us to realise that glaciation in the past was a factor which must be considered in the distribution of living forms.

We have, then, definite proof of vast climatic changes in Antarctica, and can understand that a closer knowledge of the past fauna and flora may render great assistance in the elucidation of problems of distribution in the Southern Hemisphere.

Before leaving Antarctica itself, I would like to refer to an important and interesting point—land movements as recorded by Raised Beaches.

There is no doubt that glaciation has some time since reached its maximum in Antarctica. This is evidenced by land features and also by the diminution of the Great Ice Barrier. This mass has been retreating inland since Ross's records were made in 1841. It has been found that about thirty-five miles of the mass have disappeared during the seventy years in the region of McMurdo Sound. This may be taken as an indication of lessening glaciation and less rigorous climatic conditions.

The raised beaches which were discovered in the region of Cape Barnes might reasonably be explained as an emergence or recovery resulting from the lessening of the huge ice-weight after maximum glaciation had been passed.

In attempting to map in the land areas and connections of the past we will be compelled to rely to a great extent on our knowledge of living and extinct life forms from the standpoint of distribution. This is due to our lack of knowledge in regard to earth movements, and I would here refer to an important omission in our attempts to unravel the secrets of Dynamical Geology—I refer to the absence of combined efforts to record the exact doings of our Coast lines.

We know that no part of our land areas can be regarded as stable, and that movements of importance in regard to land masses are extremely slow and imperceptible. Had we at our disposal the exact records of the movements of the various Coast lines of our land areas for the past two hundred years, or more perhaps, we would in all possibility have a guide which might enable us, in a broad way, to look more confidently and precisely into the more recent past, and even to look into the future. We ourselves may not benefit from the results obtained, but we owe it to the future generations to initiate such observations.

We shall see later that when disruption and submergence of a large area has taken place in the past, it will frequently appear that a corresponding emergence has taken place in another direction.

In other words, there is a compensation, and while this has been a great factor in the distribution of Animal and Vegetable life in the past, it adds considerably to the complexity of the problems of that distribution.

Bearing in mind the gradual nature of earth movements and the long periods of time during which any particular movement may be exerted—remembering at the same time the idea of compensation—we must realise that future great movements may even now be in their birth, and that even yet movements which have been at work for enormous periods of time, and have been responsible for the present distribution of land and sea, may be at work with diminished effect.

Think of the valuable information we might obtain had we the records of the movement of the Coast of Antarctica during the past two hundred years. The forces which have broken down the connections between Antarctica and other land masses, and separated other connections in the Southern Hemisphere, may still play a part in the movements of our own coast and that of Antarctica.

We shall find later that in Permo-Carboniferous times there existed in the Southern Hemisphere a large and continuous land area—Gondwanaland—linking up the various Southern continents and India, as postulated from a study of extinct plants and animals.

Now, in this connection it is to be remarked that although South Africa has had its connections with America and India, the only parts of this ancient southern land mass which are supposed to have been directly united with Antarctica are those other than South Africa. It is interesting here to note that an elevation of Antarctica and of these other continents through 3,040 fathoms would connect up Antarctica with South America, New Zealand and Australia. This has a special significance, since we can interpret the soundings in these regions as indicating a closer relation with the other continents than with South Africa. We will see later that in all probability these other areas were connected with Antarctica in Cretaceous times, and perhaps even as late as early Tertiary times, whereas South Africa has been both directly and indirectly separated from the other Southern continents since the beginning of Mesozoic times.

The idea that the oceans are permanent expanses and that, grossly considered, they have been retained throughout the existence of the earth, can no longer be tenaciously adhered to, in view of our knowledge of the distribution of living and extinct forms of life.

It is a very surprising fact that so many primitive types of living forms are restricted to the Southern Hemisphere and part of India—a composite area which would correspond to the ancient Gondwanaland. Attempts have been made to explain this by assuming that forms arose in the Northern Hemisphere and radiated therefrom, so that the more primitive types would be found furthest from the centre of origin, and that the latter area would be peopled by more recent types. Such "polar theories" do explain many distributions, but in many cases the evidence of palæontology gives anything but support. Further, if such a theory be correct, then we would have to assume some general cause for the limitation of the area of origin to the Northern Hemisphere. When we consider certain types, their past distribution, and the climatic conditions obtaining during their time of origin, it is impossible to find any such general cause.

For example, it is well known that the Marsupials are restricted at the present day to the Australian and South American regions; but that Marsupials abounded during Mesozoic times in Europe and North America. Are we to regard their present restriction to the Australian and South American areas as the result of the destruction caused in their ranks by the evolution of higher forms of mammals in the Northern Hemisphere? That such destruction did take place there is no doubt, but strangely enough the fossil forms of the Northern Hemisphere belong to a division known as the Polyprotodonts, which live to-day in South America and Australia. The latter areas, however, also possess forms known as Diprotodonts, which differ from the Polyprotodonts in having a smaller number of incisor teeth, and in the small size or absence of canine teeth; and these forms are unknown in the fossil condition in Europe and North America. This is explained by the opposite school of thought by assuming that a land bridge existed between Australia and South America, and that this land bridge was Antarctica.

The Polyprotodonts once universally spread over the lands of the globe, became isolated from the other areas except South America, and thus were protected from the more highly evolved Mammals which destroyed the Marsupials of the northern areas. This isolated Polyprotodont stock gave rise to Diprotodonts, possibly in Australia, which migrated to the American area. Although Diprotodonts are poorly represented in the latter area at the present day, we are familiar with a number of fossil forms from Patagonia.

The occurrence of huge fossil land tortoises of similar form in Patagonia and Australia supports such a contention.

Were this the sole evidence for a land bridge between these two continents, the argument based on the negative evidence of the Northern Hemisphere might well be challenged. But we shall see that there are many other distributions lending it support.

Let us now consider a much more lowly group, which includes the annulate freshwater and terrestrial worms, such as the Earthworm.

About fifteen years ago Beddard obtained from a subterranean well in New Zealand a new aquatic genus which he described under the name *Phreodrilus*. This form was so peculiar that it could not be included in any of the known families of this group of worms. It was then found that forms which had been found in South America and the Falkland Islands, and had been described under another name, belonged to the same genus. Since then a special family has been created to include these forms and others which have now been found in Falkland Islands, New Zealand, Campbell Islands, Australia, Tasmania, Kerguelen Island, and South Africa.

Anatomical evidence supports the idea that the family is an ancient assemblage, and their habitat taken into consideration in conjunction with their circumpolar distribution is interesting. With the exception of one genus, which is unique among the group in that it lives in close semiparasitic association with the freshwater crayfish—*Astacopsis*—of Australia, they are restricted to cold habitats. These conditions are obtained in some cases through the latitude of the habitat, in others by extreme bathymetrical isolation assisted by the seasons. In South Africa, for example, they have been collected on Wellington Mountains, Stellenbosch Mountain, and Table Mountain, but further, not only does investigation show that they are inhabitants of mountains solely, but also that they disappear in some manner or other —no doubt into the soil—during the hot months of the year.

In noting their restriction to cold habitats and to the Southern Hemisphere it must be borne in mind that no representatives have been found in the Northern Hemisphere, which has been much more seriously investigated in the past. This is very significant. The fact that they are restricted to habitats with low temperatures may be rationally interpreted as signifying that such a common feature is characteristic of the group, and in all probability of their common ancestral stock, or as the result of their inability of carrying on the struggle for existence in habitats where other forms of *Oligochæta*, etc., find favourable conditions.

The question now arises, whether the Phreodrilidæ enjoyed at one time a much wider distribution and have since disappeared in most parts, or whether we are to regard them as forms which made their appearance in the Southern Hemisphere.

Now, it is interesting here to note that although none of the group is known in the Northern Hemisphere, yet in that region there occurs a family—Lumbriculidæ—which is unknown in the Southern Hemisphere. Further, this latter family occupies a position of the same phylogenetic status as do the Phreodrilidæ between the two main divisions of the Oligochæte worms, and this is significant when their respective restricted distributions are considered. Both may have arisen, and no doubt did, from a common stock, and it seems highly probable that they have been evolved in the regions now occupied by them. That there has been no intermingling of the two races and no spreading into the other Hemisphere by either of them, and the fact that both have a circumpolar distribution, must signify a close association of the land areas of the Northern Hemisphere, and a corresponding intimate relation between the continents of the Southern Hemisphere. Otherwise it is hard to understand why two such groups should have such a complete circumpolar distribution in their respective hemispheres.

The Phreodrilidæ have been preserved for us on the tops of the mountains, and apparently in abundance in South Africa, as living relics of the fauna which flourished in that old land area—Gondwanaland—which once linked up our Southern continents, stretching across the Atlantic and Indian Oceans. If we can regard their adaptation to low temperatures as a common ancestral character, they may be forms whose distribution was greatly helped in a circumpolar direction by the glacial conditions which obtained during the time of existence of Gondwanaland.

Many other examples with a similar limited distribution could be mentioned, but in many of them we cannot put too much reliance. At all events, although many of them may not offer such clear proof of southern land connections as the examples chosen, yet their distribution is readily explained by the assumption of that connection, and when taken into consideration in conjunction with the special examples chosen, may be regarded as corroborating the conclusions drawn from those examples.

For example: the blind snakes—Typhlopidæ—are restricted to Australia, India, Africa, Central and South America; Cystignathid frogs are restricted to Australia, Tasmania, South America, Central America, and the southern portion of North America. These limited distributions receive support from the negative evidences of Palæontology. We then see that there is strong evidence in support of a closer relation between the Southern continents *inter se*, and Antarctica.

The next question concerns the time during which such connections existed. In this inquiry we are assisted by the fossil reptiles which are well represented in the Karroo rocks of South Africa. The earliest fossil reptile known in South Africa is a form—*Mesosaurus*—which was found in the lowest Karroo beds, namely, the Dwyka strata. Strangely enough this form preceded the bulk of the Karroo reptiles by a long period, and is very similar to an American form. That both the South American and African forms had a common ancestor there can be no doubt, and the occurrence of practically the same form in both these land areas is well explained by the existence of a trans-Atlantic land bridge, at the end of Palæozoic times—Permo-Carboniferous. The original home of the South African reptiles, judging from their relative times of appearance in America and South Africa, seems to have been in the northern portion of South America.

The long interval between the arrival of *Mesosaurus* and the succeeding forms in South Africa is to be explained by the existence of glacial conditions in this part of Gondwanaland, which thus acted as an impediment to migration.

This land bridge, judging from the results of evolution in the American and South African forms respectively, would seem to have broken down.

It is interesting to note here that in the Bokkeveld beds, which lie immediately above the Table Mountain sandstones, there occur fossils which are identical with forms found in the Devonian rocks of the Falkland Islands. These fossils were inhabitants of sea waters, and it is highly possible that their occurrence in both areas may indicate a common shore line to both the land areas whence these sediments were derived. This is, of course, uncertain, but if it did exist this common land bridge of Devonian times would represent that mentioned above as existing in Permo-Carboniferous times.

One of the most important discoveries in connection with this problem is that of fossil plants, as mentioned earlier, in the Antarctic regions. In addition to the forms found in Antarctica, others which existed contemporaneously with them are known from South America, India, and Australia in common with South Africa. The *Glossopteris* flora which flourished in the same areas during Permo-Carboniferous times is regarded as having originated in the Southern Hemisphere. This is very significant when we bear in mind that previously these areas had been peopled by the same kind of flora as the Northern Hemisphere. This *Glossopteris* flora grew in such abundance as to constitute the material which gave rise to the Coal Measures of the Southern Hemisphere, as, for instance, in New South Wales. The *Glossopteris* flora reached Europe at a later date. We have yet no record from Antarctica, but it is most highly probable that the Coal Measures which have been discovered will, ere this, have yielded to Scott's expedition proof of the existence of the same in Antarctica.

When we realise that the same genera and species of this flora have been found in the various Southern continents, and in rocks of the same age as indicated by their relation to the glacial beds, nothing but a land connection will give a satisfactory explanation. Similar conditions prevailed in the various areas, so that along a land connection the newly-evolved forms spread with rapidity and flourished.

The fact that the time during which this flora flourished in the various areas coincides with that during which, on zoological grounds, a continuous southern land mass is postulated to have existed, is very significant.

We have, then every reason to believe in the existence of a continuous Southern land in Permo-Carboniferous times, but that the trans-Atlantic portion early broke down. Across this land tract we can picture the migration of many forms which are preserved to us in their primitive condition. Among these we may note *Peripatus*—a form which occupies such an important position between the Annulate worms and the terrestrial Arthropods. It is interesting to note that only recently this form has been discovered in India, so that it is now restrictedly distributed over all the main remnants of Gondwanaland. Across this area we can well imagine the migration of that primitive reptile—*Sphenodon*—to its future isolated home—New Zealand and neighbouring islands, there to persist long after its relatives in other parts had disappeared. Not later than early Jurassic times we see the breaking up of the Indo-African portion of Gondwanaland—the ancient Lemuria—and probably a series of insular areas stretching from Madagascar to India.

In Cretaceous times it would seem that the continents had much the same configuration as that which now characterises them, but South America and Australia were still linked up with Antarctica. In this way the Diprotodont Marsupials evolved in one area migrated to the other across an Antarctica which, as we have already seen, enjoyed a much milder climate than the present even into Tertiary times. This bridge between South America and Australia may have been retained even into early Tertiary times.

For more definite mapping in of the various continental masses during Mesozoic and early Tertiary times we require information other than that now accessible to us, and that we may reasonably hope to acquire as the result of scientific investigations in Antarctica.

TSUMEBITE: A NEW MINERAL.—A few months ago Karl Busz described in the *Festschrift Deutsch. Naturforsch. Aertze* (1912, pp. 182-185) a new lead copper phosphate from German South-West Africa. The mineral is found in the form of small emerald-green monoclinic crystals, with cerussite and chessylite, on snow-white calamine, together with reddish brown dolomite, in the Tsumeb mines, Otavi. The specific gravity of the new mineral was given as 6.133. Independently Rosicky described in the *Zeitschrift für Kryst. Min.* (1912, pp. 521-526) under the name Preslite, what was afterwards admitted to be the same mineral, observed in small emerald-green crystals associated with chessylite, cerussite, calamine, and dolomite. The crystals were described as imperfectly developed, and appared to be orthorhombic with complex twinning. To each description an analysis of the new mineral was appended:—

	Busz.	Rosicky.
Lead oxide	63.77	65.09
Copper oxide	11.79	11.97
Phosphorus pentoxide	12.01	10.26
Water	12.33	—

A COMPARISON OF MUNICIPAL ELECTIONS UNDER THE PRESENT SYSTEM AND UNDER THE TRANSFERABLE VOTE.

By John Brown, M.D., C.M., F.R.C.S., L.R.C.S.E.

SYNOPSIS.

1. Object of election of Municipal Councillors.
2. Pretoria Municipal election of 1909.
3. Purpose of present paper: a comparison of the two systems of voting.
4. The voter's work in each system.
5. The voter's position as to representation.
6. Cause of the rare failure to secure representation.
7. How the transferable vote secures true representation and equal sectional representation through the quota.
8. Illustrative example of the plan of finding the quota.
9. Working of the transferable vote at Pretoria in 1909.
10. The relative majority and the absolute majority.
11. An extreme case showing possible results of present plan.
12. Actual and possible results with more than two candidates.
13. Limitation of choice of candidates with the present system.
14. Opportunity for faddists under the present plan.
15. Danger of personal antagonisms for candidates and voters.
16. Danger of undue influence for local needs and wishes.
17. The election of one member in a small constituency is the chief cause of all the present drawbacks.
18. Canvassing, conveyance to the poll, undesirable voters now determine the result of the election of one of two candidates.
19. Limitation of candidates from unsatisfactory conditions of election.
20. Present apathy largely due to present method of election.
21. Three members, the minimum for election by the transferable vote.
22. This secures true representation. More efficiency got with more members.
23. The transferable vote promotes combined action of candidates.
24. The transferable vote obviates the present drawbacks.
25. Percentage of voters on the roll who voted at Cape Town and Pretoria.
26. Effect of the transferable vote on the voter.
27. Effect of the transferable vote on the councillor.
28. Effect of the transferable vote on the candidate.

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1. In the election of a Municipal Council or any other representative body, the object aimed at is the representation on the Council of the voters.

2. Since 1909 at Pretoria the citizens have enjoyed the advantages due to the use of the transferable vote, or as the Australians call it, effective voting.

At the first trial of this system, which was entirely new to them, there were thirteen candidates from whom six members of Council were to be chosen.

Two thousand eight hundred and fourteen voters voted, and on only thirty-seven of the ballot papers examined at the election did the voters fail to secure representation: and this failure was entirely due to their own faults, and might have been avoided with a little care.

There is little wonder that this is called effective voting.

3. The object of this paper is to compare this system with the plan employed at present, and this object will probably be better attained if we take, as an example, a smaller number both of voters and members, say, fifty-one voters, who are to elect three members from six candidates.

4. At such an election under the present system, each voter would mark a × opposite the name of the three candidates for whom he voted; under the transferable vote system he would mark with the figures 1, 2, 3, etc., as many candidates as he chose, in the order of his preference. Each voter would have only one vote in place of three, but by marking the four candidates whom he thought the best he would make it absolutely certain that one of the four he marked would be on the Council as his representative. He would be at no disadvantage in having only one effective vote instead of three as at present, for every other voter would be in the same case.

5. If at present the three candidates he marks are all unsuccessful, his three votes are lost; but under the new system if the first three choices were all marked for unsuccessful candidates, his fourth choice would secure his representation, in helping to elect that one of the three members whom he most preferred. He would have given an effective vote.

6. The thirty-seven Pretoria voters, who failed to secure representation, failed simply because they marked too few choices—twelve marked only one, twenty-two marked two, and three marked three, and all those marked were unsuccessful candidates. But, as we have seen from our small election, every voter who marks one more choice than the number of the unsuccessful candidates, makes perfectly certain of securing representation.

7. In this way effective voting secures true representation, for every voter is represented on the Council: and thus it is that minorities as well as majorities get represented, and that any section of the voters numerous enough to give a candidate a number of votes, equal to that received by the other members, will secure his election.

For with the transferable vote, not only are the votes given to unsuccessful candidates transferred to other candidates, whose election they can help, but when a member has proved himself so popular that he secures more votes than his share, all his majority votes are transferred from him, because he does not need them, to the next lower choice on each voting paper, who stands in need of more votes to secure his election. Thus each member elected receives the same number of votes. There are neither unsuccessful minority votes nor useless majority votes, but each member is elected on receiving what is called the quota—that is, the smallest number that will ensure the election of a member.

In this way we have equal sectional representation of every section of the voters, large enough to give a candidate a quota. We have one vote, one value, every vote is used that can be counted, and each member gets the same number of votes, and all voters who choose receive representation.

8. Let us look once more at our illustrative case of 51 voters and three members. We can divide 51 votes into four groups of twelve each, with three votes over; and we thus see very plainly that if three men each got one of these groups and one of the three votes that were over, we would have three men with thirteen votes, and only one group of twelve votes would remain over, which would not be enough to elect another man. So here thirteen is the quota.

Three equal sections of thirteen voters can elect three members from the six candidates; and even if all the other twelve votes went to one of the three unsuccessful candidates, he could not secure election. Every section of thirteen voters is represented by one member, and each vote is equal to one-thirteenth of the quota.

If each of the 51 voters marked four choices, everyone of them has secured representation; and these twelve votes in this case that could not be used will, nevertheless, each contain the name of one of the six elected members marked as one of that voter's choices, and thus all the fifty-one voters have secured representation.

We got the quota by dividing the number of votes by one more than the number of members to be elected and adding one to the quotient, that is, to the number expressing the result of the division. Just so at the Pretoria election. If we divide 2,814 by seven, one more than the six members, we get 402, and adding one we get 403: and if the six members get each 403 votes, that uses 2,418 votes, leaving only 396 votes over, not enough to give another candidate the quota of 403 votes.

9. At the Pretoria election, following the rules laid down, the surpluses were first distributed, and then the lowest unsuccessful candidate was excluded, and his votes distributed; and the same process was followed till all but seven of the original candidates were left. Five of the seven each got 403 votes, and the sixth had 17 more votes than the last unsuccessful candidate, namely, 367—only 36 votes less than the quota.

Thus, in an election with 2,814 voters, only 36 fewer than the greatest possible number of votes that could have been counted were actually used in the election of the six members; and only 37 voters of the 2,814 failed to secure representation on the Council, because they marked too few preferences or choices.

Such is *the working of effective voting or the transferable vote.*

Let us look now at the present system first with regard to these two points: the representation it affords, and the number of votes actually effective in electing the Councillors.

10. Under the present plan of voting we have almost everywhere single-member ward elections by a relative majority. This is the good old English method, used for the last 650 years, of election by a relative majority: that is, a member is elected when he gets one more vote than the next highest candidate. In most other civilized countries the member requires to get one more than half the votes, or an absolute majority; and to secure this, second ballots, or the transferable vote applied to the votes given for the lowest of the candidates, are employed.

Where in a single ward, or single-member constituency, we have only two candidates, the election in England is on the same principle—that of the absolute majority; for in this case, as there are only two candidates, the English rule of election by a relative majority, that is, by one more vote than the highest candidate, means election by one more than half the votes. The relative majority coincides with the absolute majority where there are only two candidates, and we see the present plan at its best.

11. Yet here in the closest possible contest—in our case of 51 voters—the 25 voters for the unsuccessful candidates get no representation, because they were one fewer than the 26, who elected the member. The last voter for the successful candidate decided, in fact (1) which of the two lots of 25 voters should have representation, and which should not; (2) which 25 votes should be effective, and elect the member, and which should be non-effective useless votes. In such a case a majority of one decides these questions. The same thing would happen under present rules, were three members being elected in place of one. One single voter might have the power of saying which half of the voters should be represented by three members, and which half by none.

12. Where there are more than two candidates the drawbacks are greater. At the last Municipal election in the Municipality of Claremont, there were four candidates for one seat: 223 votes were given for the member elected, but the other three candidates received 312 votes, so that 223 votes, a minority of 89, elected the member, and were represented by him. One hundred and forty-four votes were effective in the election. While 391, or 100 more than double that number were non-effective, wasted votes, so far as the election of any one was concerned.

In a close contest—in our case of 51 voters—4 candidates might have received 14, 13, 12, 12 votes respectively. In such a case, 14 voters, a minority of 23 would secure representation; while 27 voters failed to do so. The actual Claremont case showed a great waste of votes, for there one hundred more than double the effective votes were wasted; but the failure in securing representation, which is the more serious matter, is much worse in our supposed case, as nearly twice as many members fail to secure representation; 27 voters fail, while 14 get it.

Besides these *two* striking drawbacks there are others.

13. (3rd.) Where only two candidates contest the seat, the choice of the voters is very limited. Many voters would prefer some other representative, and in truth merely express their opinion as to which candidate is the more objectionable to them; while, as we have seen, increase in the number of candidates adds both to the poverty of representation and the number of wanted votes—under the present system of election.

14. (4th.) With only two candidates, a great opportunity is given to the so-called faddists. These are voters with whom some special question holds a very much more important place than it does with the majority of other voters. It might be, as it was in Edinburgh, the question of the running of Municipal trams on Sundays. Say three among our 51 electors waited on the two candidates in turn, and said here are three votes, counting for and against as six in this election; if you promise to vote against the Sunday running of the trams, you will get them; if you do not, they will be given against you.

15. (5th.) Where two candidates contest a seat, the tendency to the development of feelings of personal antagonism among the supporters on each side, even if not in the case of the candidates themselves, is very apt to become strong, and to cause ill-feeling, it may be for long after the election is over.

16. (6th.) The smallness of the electoral area for the election of one member tends to give undue prominence to what are trivial local matters, and may give rise to log-rolling and the exchanges of mutual support in the Council itself.

17. These *six* faults, inherent in small single-member constituencies, arise to a great extent from the fact that one vacancy has to be filled by the voters in one small constituency, and that in almost every case not more than two candidates come forward.

Hence follows failure to secure representation, great waste of votes, limitation of choice of candidates, the opportunity for faddists to sell their votes for specious promises, personal antagonisms, and the undue prominence of local demands; and *three* other serious drawbacks have to be added.

18. (7th.) When there are only two candidates, or the contest lies between two, all votes get a fictitious value. They are worth two in the counting, because they are one vote lost to the opponent and one gained for the man who gets it, and hence comes the great importance of canvassing, and keen competition, and the bringing to the poll of hosts of voters who would not otherwise take the trouble of voting; and the determination of which candidate shall win by the number of the more ignorant and apathetic voters that his purse and his friends' efforts can

bring to the poll. This is the determining factor in every hotly contested election. Far better would it be for the town or city that its Councillors were elected on the deliberate opinion of those citizens who are able to judge of the merits of the candidates, and have independence enough to convey themselves to the poll.

19. (8th.) In place of getting the services of the most able men, our choice is at present limited by the expense of the election and the reluctance of many, who would make the very best of Councillors, to face the expense, the work, the worry and the unpleasantness of a contested election with, perhaps, an inferior candidate with powerful local influence. This is the reason why many of our very best citizens never for a moment dream of making the sacrifices that have to be faced by every member who tries to discharge the duties of a Councillor.

20. (9th.) Lastly, it is owing to these inherent faults and drawbacks of our present system that such deadly apathy exists on the part of the citizens, not only as to the election, but also as to the works and doings of the Councillors.

The giving of the effective vote will in a short time rectify all these drawbacks.

21. In marking his ballot paper the man marked (2) is the candidate nearest in his views and fitness for the post, in the opinion of the voter, to the man marked (1). They both belong to the same party, or the same ticket, where there is one. A surplus vote goes thus to another candidate of the same party, or ticket, or to another candidate of similar views.

The Municipal Council is not a legislative body—its by-laws even are subject to the approval of an outside authority—party has no place in its working, but is for all that the main influence, in most cases, in the election of its members.

In a contest between *two* candidates no voter would dream of marking a second choice on his voting paper. So we must have at least three members, if a surplus vote is ever to be transferred; and two of these members must belong to the same party or group, in the opinion of the voter, whose vote has been transferred.

Thus, you see, for the full use of the transferable vote we must have electoral areas large enough to elect three members at the election.

22. Even with this minimum, the transferable vote gives true representation; but, with only three members to be elected, the opportunity of the transfer of surplus votes is also at a minimum—only one surplus can be distributed, and only one member can benefit from it. In fact, the larger the constituency and the greater the number of members to be elected, the more efficiently does the transferable vote work, up to the limit where the number of members is not too great.

In 1912 fifteen members were elected at Pretoria with comparative ease, and with results in every way more satisfactory than even at the two previous elections, when six and seven members respectively were elected. Thirteen members got the quota, the fourteenth was only seven votes short of it, and the fifteenth was less than fifty short. Any section of voters, numbering 234 voters, had it in its power to return a member; and the Council was thoroughly representative of the voters. In giving evidence before the Commission of the House of Lords, which in 1910 gave its Report Cd. 5163, Lord Courtenay stated that in his opinion 15 or 17 members of Parliament were not too many to be elected in one constituency by the transferable vote.

23. The fact that with the transferable vote the electoral area is at least three times as large as at present, increases the inducement for two or three candidates with similar opinions to work together; to form a ticket, each member of which in trying to secure support for himself asks also for second and lower choices for his companions, just as they are doing for him in districts where they are popular.

To revert to our illustrative example. We would have an electoral area three times as large, with 153 voters, and in place of six candidates we may very probably have seven. Say one group of the three old members, a ticket of three; another group might be made by two of the formerly unsuccessful candidates; and two independents, well known in the area, might be fighting for their own selves alone. The larger group would each urge all their voters to place their three members at the top of their list of choices; dividing the work by three, and each helping the election of the other two by second choices, on what, he fondly hopes, will be his surplus. The quota will now be $\frac{153}{3+1} + 1 = 39$. If one of the independents is so well known and so well liked as to get 39 supporters' votes, his election is sure. He need not get 39 first choice votes; for, where a second choice or lower choice becomes effective, it counts just as much as a first choice, if it comes from an unsuccessful candidate.

24. Let us look now at the nine drawbacks of the single ward election and see what the transferable vote does for them:

1st. The transferable vote gives true representation to every voter.

2nd. It wastes no votes, where the voter uses the privilege it offers.

3rd. There is a much larger choice of candidates.

4th. The faddists have lost the chance the single ward election gave them, their votes now carry only their own proper value; if their number entitles them to a representative, they will get one; but their votes no longer have a fictitious value, owing to their being only two candidates.

5th. The personal element of antagonism is gone; each candidate is struggling for the quota, not fighting one antagonist.

6th. Undue local influence is gone. Local influence is now worth just as in the case of the faddists—exactly its numerical value towards the election of the candidates, whom its voters individually must appreciate.

7th. Canvassing and bringing up indifferent voters to the poll is no more the powerful instrument it was, when only one of two candidates had to be elected. Personal application to individual voters is now not so efficacious as public speaking, and appeals through the press to the more intelligent sections of the voters, and the general recognition of the candidate's reputation and fitness for the post.

When every vote is effective it will be the voters who will canvass each other for the sake of their party, or from their knowledge of the fitness of a candidate. It will be the voters' anxiety for the success of their candidate, instead of the influence of the agents and friends of the candidate in bringing indifferent and often ignorant voters to the poll, which will determinate the result of the election.

8th. The inducement to citizens of the right stamp to come forward and offer their services will be very much increased.

When the element of personal contest is gone, failure at the poll is deprived of the stigma of defeat, and the fact that six other men are, in the opinion of your fellow citizens, preferred as their representatives, is rather a matter of congratulation than otherwise.

25. In Cape Town in the very hotly contested ward elections in 1909 only about 42 per cent. of the voters were got to the poll, though two outside organisations, the Citizens' Guild and the Ratepayers' Association, did their best to bring up all voters to the poll. At Pretoria the trial for the first time of a perfectly new system of voting, explained by the able secretary of the Proportional Representation Society and much boomed by all the newspapers, brought 61 per cent. of the registered voters to the poll; 2,814 voted. In 1910—though the register was larger the novelty was gone—2,616 only voted, or 54 per cent.; in 1911 the experience of what effective voting was probably began to tell, for 3,878 voters, or 63 per cent., went to the poll.

In conclusion, let us consider what the transferable vote means to the voter, the councillor and the candidate.

26. So far as the voter is concerned, it means that every voter should know it is his own fault if his vote does not help to elect a member. It means that every one of the larger number of voters on the roll who do not vote should know that this is true of every voter who votes on the other side—that not one of *their* votes will be lost except through their own fault, and that he had better hurry to the poll if he wants to make as good use of his own vote. What stronger stimulus can be imagined to get rid of the deplorable apathy of the voters under the present plan?

27. To the Councillor it means that he would know that he and his fellow members were elected by the practically unanimous vote of the constituency; that he need have no doubt or

fear regarding his action, so long as he does the best he can according to his judgment; that there need be no afterthought or previous scruple as to how the electors or the public will view his action.

28. What does it mean to the candidate, the citizen who is willing to give his services for the good of the town, who gives time and labour and faces work, worry, trouble and expense, for which in many cases he gets little thanks, and sometimes misunderstanding and misrepresentation; to the candidate who now in towns has to go round and canvass, personally to ask people to vote for him, to pay agents to do this, and to get all his friends to help as unpaid organisers? It means to him that he must face the fact that it is impossible to canvass 99 per cent. of the effective voters; that he may spare the time, trouble and money, and the sacrifice of self-respect involved in asking for votes. It means that through the press and on the platform he must make his views known and show his suitability for the post, and that his friends all over the constituency must help him to do this, and help him by their votes.

With canvassing much diminished there would be less difficulty in getting good men to come forward as candidates, and it would be better for the municipality that its councillors should be chosen by intelligent men, giving an intelligent vote on the merits of the candidates, than, as now, by voters who have to be begged for their votes, taught and told how to vote, and who must be driven to the poll in carriage, cart, or motor to get them to vote at all.

THE BRITISH ASSOCIATION.—Sir Oliver Lodge has been nominated by the Council of the British Association for the Advancement of Science as President for the Birmingham meeting, in place of the late Sir William White.

A NEW MINOR PLANET.—On two plates exposed by Mr. H. E. Wood in the Franklin Adams star-camera of the Union Observatory, Johannesburg, on the 7th and 8th of August last, with the object of obtaining photographs of the planet Eros, a small unknown planet was discovered to have been photographed close to Eros. To this planet the provisional name 1912 T 16 has been assigned.

MESOTHORIUM.—This body, which occurs in the monazite sands of Brazil, and costs half the price of radium, is stated to possess, weight for weight, an activity 300 times greater than that of radium. Its effects, together with those of other radioactive bodies of the thorium series, have just been studied by Dr. Ledoux-Lebard. Injections of mesothorium notably diminish pain in cases of ulcerated cancer, and raise the general state of unoperable cancer patients.

THE LIMITS OF SCIENCE IN THE MATERIAL UNIVERSE.

By Orlando Middleton, A.R.I.B.A.

This paper is intended to discuss very briefly and simply how far science has taken us towards the solution of the greatest problems of the material universe. It is necessary, therefore, in the first place, to venture some statement of what these greatest problems are. Herein doubtless there will be an opportunity for considerable variety of opinion, but I will say at once that there are five questions which appear to me to rank first among the many unsolved conundrums which science endeavours to elucidate, and these five are, I think, not only the greatest questions on the subject that we can consider, but to some extent they include and cover every other that could possibly be raised in respect of the material world. These five questions are:—1. What is the *origin* of matter? 2. What is the ultimate *composition* of matter? 3. What is the *extent* of the Universe? 4. What is the extent of *Time?* 5. What is the ultimate *force* of the material Universe?

It is evident that some of these questions take us far beyond the boundaries of Science, into regions which would, if we attempted to follow them so far, soon involve us in a theological controversy, but my object is only to consider how far our present knowledge will enable us to investigate them, and to remain strictly within the scientific point of view.

Of course, it is impossible in a short paper to deal in anything but the most cursory way with such a subject. I shall merely try to put a few of an interested layman's thoughts together, with some ascertained facts, under the five above mentioned heads.

I. *What is the Origin of Matter?*—This may be very soon disposed of. Astronomers tell us that they can see from 100 to 1,000 million stars by means of the most powerful telescopes and most sensitive photographic plates, and probably there are thousands, or millions, of times more dark stars, that they do *not* see. They also tell us of almost endless quantities of meteoric matter scattered more or less unevenly throughout the regions of space, and of still more diffused matter which we sometimes see in the form of comets and nebulæ.

Some of the stars, they tell us, in a vague way, appear to be drifting in a more or less definite direction, but as to how all this matter came to exist in the universe, they do not appear able to afford any light at all.

According to some conceptions regarding the actual *existence* of matter, it exists, and all things exist, only as ideas of the brain; but this takes us into the mysterious realm of *metaphysics*, and is therefore beyond the present discussion. From a practically *scientific* point of view, it may, I think, be said that we are little, if any, nearer the solution of the origin of matter than we were a thousand years ago, and it is fairly safe to hazard the reflection that we are never likely to be much nearer. Thus we have evidently reached the limits of Science in this direction, and can now proceed to the next problem.

II. *What is the Ultimate Composition of Matter?*—Vast discoveries have been made since the comparatively recent time when the elements of which everything is composed were put down as "earth, air, fire and water." Now-a-days some 80 to 90 substances have been discovered in the world, which, though some of them, like Radium, may break up *spontaneously*, refuse to yield anything different to themselves, whatever chemical or mechanical process *we* may subject them to. They have until recently been considered as composed of one material only, and have been called "The Elements."

The Spectroscope has shown us that the same elements which occur on earth, or a great many of them, abound in our Sun; but scarcely any new element has been discovered outside our globe that we do not possess. The gases Asterium and Nebulum, recently found to exist in nebulæ and hot stars, and also Coronium, which occurs in the sun's corona, have not been discovered on this earth. We seem to be reaching the limits of Science as we pass from the eighty odd elements, to *speculations* as to whether Hydrogen is not actually the one original element. We find in favour of this theory the fact that the atomic weight of nearly all other elements is exactly divisible by that of Hydrogen. It has been thought that the element Helium, which at one time was not known to exist elsewhere than in the sun, may be the original element. It would certainly seem very improbable that the ultimate matter, of which the whole universe is composed, should be some eighty odd kinds of substances, varying from each other in all manner of ways, as to their quantities, weight, and nearly all other properties. It does not seem likely that Helium is the element out of which all others are composed, except that the atoms of the remarkable element Radium actually break up and give off atoms of this Helium gas, a fact which shows clearly that Helium forms a component part of *at least one element*; and possibly with the further advance of knowledge, we may yet return to the ancient idea of the Philosopher's Stone, and find that all the elements are composed of one, and that we can produce gold, or any other, out of whichever we choose.

Although we have now discussed, in a superficial way, the question of an original element, we should make a great mistake, even if we had succeeded in finding one, if we thought we had approximately solved the problem of the ultimate composition of matter. The microscope will show us much that would never have been discovered by the unaided eye, but we must give science credit for having penetrated vastly further into the realms of minuteness, than has been, or is ever likely to be reached by optical instruments; she has calculated the actual size of the atoms, or individual units of which the elementary, or for that matter, all bodies, are composed; she tells us, for instance, that one of these atoms compared to a drop of water, is no larger than a rifle bullet compared to the whole earth, their size being the thousand millionth of an inch in diameter. We are told that they are constantly in motion, and in solids, constantly colliding with each other; in ordinary air the motion is not regular, but consists of zig-zag paths, each straight portion being so short that it is on an average ultra-microscopic, and each atom strikes another about six thousand million times a second. The layman might, I think, at this stage, be excused if he ventured to enquire satirically of the professor of science if he does not find the atoms somewhat too coarse, and if he would not recommend their undergoing a still finer powdering up process. The question, however, might just as well be asked seriously, for the so-called "Electron Theory" has now been generally accepted in scientific circles. From it we learn that the atoms, so far from being, as was previously supposed, the smallest and indivisible parts of matter, are actually only the gathering places of still smaller bodies. We might compare them to systems of suns, round with planets, or electrons, of considerably smaller dimensions, revolve. More, indeed, is now known of these electrons than of the atoms themselves, and the theory of their existence and movements explains so completely various phenomena of electricity, gas discharges, radium rays, spectroscopy, and chemical affinity, which were before inexplicable, that the theory may now be considered to be as firmly established in dealing with matter within the molecular, or atomic, range, as the Copernican theory is, in dealing with the heavenly bodies. Not only are we told the number of electrons per atom, we are told that they all weigh the same amount, and also that they are all alike in size. It is known that an atom is one thousand millionth of an inch in diameter, therefore, taking the comparison between the sun and the earth to be true for the atom and electron, as it actually is, at any rate comparing their masses, approximately for the heavier metals, the electron must have a diameter of about a hundred thousand millionth of an inch. The length of time taken by electrons to complete their orbits round their atoms varies considerably, and this matter is of importance to us, because the various effects of electricity, heat and colour, or light, are affected by it. If the electrons have what are for them relatively very long years, *i.e.*, if they complete only a few hundred million revolutions in a second, the kind of ether waves used in wireless telegraphy are produced; if they move more rapidly the matter of which they are composed will give out dark heat ether waves; if they complete their orbits still more speedily, say at the rate of 400 billions per second, the matter of which they are constituted will give out a red heat, and with still shorter electron years the various colours will be produced, till we get to the violet and ultra violet, or actinic rays, represented by revolutions at the rate of over 750 billions per second. All these ether waves, set up by the revolutions of the electrons, travel at the same well-known rate—that of 186 thousand miles a second. But these waves are not matter at all. Waves, unless accompanied by other forces, merely give a certain motion to matter, and then leave it where it was. There is, however, another realm, besides that of tangible matter, which we must investigate. Waves of heat and light are conveyed, not only through our atmosphere, but through space, and the medium by which they are conveyed we call the ether, and it not only fills the whole of space, but also penetrates the whole of matter. Although so far as I know, there is not any definite evidence to show that ether is actually the ultimate material—if we may call it material—of which the rest of matter is composed, the fact of its extreme tenuity, as evidenced by its offering no apparent resistance to the heavenly or any other bodies, and its universal distribution, will, I think, compel us to rank it at any rate in the first place among the "Probables" for the place of distinction, and also oblige us to admit that we have now reached the limits of science in this direction.

III. *What is the extent of the Universe?*—One feels almost overawed at the very idea of endeavouring to get an answer to such a question. Only the distances of about forty stars have been determined with anything like accuracy, and the nearest of these, *a* Centauri, is so far that its light, travelling at 186,000 miles a second, takes about four years to reach us, whilst the light of the very distant stars takes many thousand times longer. Long after the discovery of the telescope it was found that the greater the power of the instrument, the greater was the number of stars to be discovered in the same area of the heavens, and for a long time it appeared that this form of discovery would go on indefinitely. It was only a matter of the power of the telescope how many suns would be discovered, and telescopic photography only at first seemed to lend its help to establish the same theory, by showing more stars on the very sensitive plate than could be seen on those less sensitive. But more recent investigations seemed to show that a boundary of this infinite source of discovery is being reached. The existence of vast numbers of dark stars, probably cooled down suns, is thought by some to prevent our seeing more stars beyond, but clearly this objection will not hold good, for, even if the dark stars exceeded the number of light stars by 150,000 to one, the heavens would be as bright as the face of the moon if the stars extended to infinity, and it may be fairly concluded from this that they do not. Authorities, however, seem to be very doubtful, generally, on this point. So we must now admit having reached the limits of science in this direction.

IV. *What is the extent of time?*—How far can science take up back in the past? and how far towards eternity in the future?

Geology, to begin with, is of little use in taking us over really great distances of time: it may deal fairly accurately with a few tens of millions of years, and show us how organic and inorganic matter has behaved since the crust of our globe got cool enough to permit of organic life, but it is mainly to astronomy that we have to turn again to take up to the boundary of science in this direction; back past the era of the formation of the primary rocks, to the globe as a floating ball of molten matter; back to a time before it had even condensed from a vapour to a liquid, when the moon was not distinguishable apart from our own centre of vapour; back to the time when what was to be the earth would only just be distinguishable, as a world in the making, from the great flat spiral nebulous mass of the sun, that extended far beyond it, beyond the orbit of our most distant brother planet, Neptune. That brings us about as far back as the Nebular hypothesis will take us, but one more theory has to be taken into consideration before we can say that science is exhausted in recording the ancient history of the universe. Science has to give a reason to account for this mighty mass of matter, possessing such a prodigious amount of heat as to cause it to be so rarefied and nebulous a state, so she tells us that there has just been a terrific collision: two bodies, perhaps both icy cold and dark, of the aggregate weight of our solar system, and consisting of the same elements, were drawn together by gravity, and possibly some additional momentum of their own, and in one moment the solid is transformed into gaseous; unknown cold to untold heat, and blackest darkness to brightest light. "The Impact Theory" has taken us to the Limit of time for the future, *as well as* for the past; for our two black globes of matter are only such as we and our sun will become some day, when all our heat has been radiated into space; but science cannot go any further, or venture to give us the date when these dark or shining suns arrived to form a part of the Material Universe. Possibly there is a still wider cycle, for we have to account for the apparently enormous waste of material and energy being thrown out continually in all directions by all hot stellar bodies. It is thought that the matter, largely composed of dust, thrown out beyond the reach of gravity by violent storms, eruptions, and explosions, from these bodies, is carried by heat and light waves to the darkest parts of space, and there accumulates by its own gravity till a globe is formed, which then must wait for a chance collision before the next step in its evolution is made. The time required for this must certainly be enormously greater than the cycle already considered, but, after all, we have not the satisfaction of feeling that we get appreciably nearer the beginning or end of time, however much our cycles are enlarged.

V. *What is the ultimate force in the Material Universe?*—How far will science take us in the elucidation of this question? Just as we feel convinced that all matter is, if we could only find it, composed of one ultimate element, so we feel sure that the ultimate end of science, when considering its forces, is to marshall them all under one, and say, "This force is the primary force of nature, and all others can be accounted for by it." It was no wonder, when Newton made known his great discoveries, that gravity was placed in the front rank among the claimants for this place of honour, but though the announcement of the law of gravity has done so much in enabling us to explain the movements and positions of celestial and terrestial bodes, and has at one step, to a great extent, evolved order out of chaos in the universe, although we owe it to the never-wearying action of this law that the earth is safely held, against its own centrifugal force, from flying off its sunny orbit to unknown regions of space. Still, we seem to have good reason for denying to it the position of honour that it seemed likely to gain. Supposing, however, that gravity *is* the fundamental force for which we are looking, we have certainly reached the limits of science here, for what explanation can we give of gravity? *Why* and *how* do two pieces of matter attract each other directly as their mass and inversely as the square of their distance, when there is no apparent connection between them whatever? I am aware that there are theories, such, for instance, as that of Professor Osborne Reynolds, which may prove to be true explanations, but for the present I think we must still say, as Newton himself said: "The cause of gravitation remains undiscovered." But great as gravity is as a source of power in the universe, it seems altogether inadequate and insignificant compared to the energy displayed in other ways. It seems impossible that gravity alone can account for the great velocity of many of the stars, for our own sun, for instance, travelling at the rate of nine to twelve miles a second, or for a star like Arcturus, travelling 400 miles in the same time. But if we are not able to account for the forces of nature, which control the motions of the stars, we seem to be still less able to give a scientific explanation of the laws controlling the almost infinitely greater energy required to explain the various phenomena connected with atoms and molecules. What is it that makes these tiny particles cling so tenaciously? Why should the atoms of which a bar of iron, for instance, is made, hold together, enabling it to sustain enormous weights? If there were not forces to hold them they would assuredly crumble, and our bar would be as dust at the least touch. It is not the force of gravity that holds the particles together. That is nothing like strong enough. Neither is it gravity that makes two or more elements combine to form a compound. We say this is due to the affinity of one element for another, but that is only a euphemistic way of admitting that we do not know what the force is. It is to the electron theory that we must return if we wish to get within sight of greater forces. In my second question—for the sake of clearness I avoided comment on their electrical significance—we considered other aspects of the electron, nevertheless the great fundamental property of the electron is, that it repels another electron; this repulsive force we recognise as *electrical*. We say, in fact, that electrons *are* electricity. A flash of lightning is nothing more or less than a discharge of electrons, and the Aurora is the display of the small electron planets, at the two magnetic poles of the earth. Actually electrons are *negative* electricity, whilst *positive* electricity is the condition of matter, or atoms, from which electrons are partially absent. In the normal state of matter the atoms have neither *too many* electrons to make it act as though *negatively* charged, nor *too few* to make it act as though *positively* charged. Fournier's imaginary experiment shows how much greater electrical force is than gravity. If we were to place two small globes of lead, weighing one gramme each, at a distance of one centimeter apart, they will attract each other by the ordinary force of gravity, but the force of attraction will be so small that it could not be measured by any known instrument. If, however, it were possible to put two globes the same size, made of negative electricity, or electrons, and to place *them* the same distance apart as the globes of lead, they would repel each other with a force of no less than 320 quadrillion tons, or, if they were placed as far apart as the North and South Poles, they would still exert a repulsive force of 192 million tons on each other. Of such a nature is the force, of which we inspan a tiny fraction, to drive our modern machinery and give us light. Wherever matter exists this force must exist too, either dormant or active. Whether still greater forces are hidden from our view we cannot say, but certainly science has not yet revealed one greater than electricity, and we may safely say we have reached its limits in this direction.

In conclusion: We have tried to answer the five unanswerable questions, and in doing so we have started with facts about each, and found ourselves nonplussed, or only landed in doubtful theories. We have, as it were, tried to climb beyond the boundaries of science, to scale the mighty heights of the Eternal mountains. With Tennyson, we may say we have tried to—

> ". . . . climb the summit's slope
> Beyond the furthest flights of hope
> Wrapt in dense cloud from base to cope."

We may have found that

> "Sometimes a little corner shines
> As over rainy mist inclines
> A gleaming crag with belts of pines."

But,

> "The highest mounted mind,
> Still sees the sacred morning spread
> The silent summit over-head.
> Fore-run thy peers, thy time, and let
> Thy feet millenniums hence, be set,
> In midst of knowledge dreamed not yet.
> Thou hast not gained a real height,
> Nor art thou nearer to the light,
> Because the scale is infinite."

ON THE MEASUREMENT OF THE PERIOD OF A PENDULUM.

By Prof. Robert A. Lehfeldt, B.A., D.Sc.

On trying to use a model of Kater's pendulum for teaching purposes, I came across a phenomenon which I have not been able to account for. When swinging with the heavy weight below, no dummy, the damping is of course small (log. dec. about 0.0008 per complete swing). The pendulum was observed by coincidences, and with amplitudes diminishing from 0.08 to to 0.03 (circular measure), results were obtained of satisfactory concordance—probable error less than 1 in the fifth place. But when the pendulum was inverted so that the log. dec. was increased to about three times its former value, it was no longer possible to get concordant results: as the amplitude fell off, the apparent period (corrected for amplitude in the usual way) fell off too, and it was impossible to say from the results what the true period for infinitesimal arc should be.

When the damping was exaggerated by means of an air vane, the change of period was exaggerated too.

Observations were taken by allowing the pendulum to cut through a mercury cup: the current was used to work one hammer of a Cambridge scientific instrument company's chronograph, while the clock worked another, and the coincidence between the two was observed aurally. The first thing that occurred to me was that, as the amplitude gets less, the pendulum takes longer to pass through the cup, and as the click of the hammer depends on the pendulum leaving the cup, this takes place later and later in phase. It is easy to make a correction for the phase, based on the dimensions of the mercury cup. This was done, and also the size of the cup was varied, but no explanation of the change in apparent period could be arrived at.

It was then thought that, perhaps, the time of immersion of the pendulum in the cup was too short to excite the electromagnet fully, and that this caused a progressive error of phase. To avoid such an effect the time constant of the circuit was reduced by using a higher electromotive force, and more resistance, but no perceptible effect was found. The extent of play of the electromagnet was varied, also, but without detecting any difference.

The pendulum was made of steel, so in case the peculiarity was due in any way to magnetism I procured a brass bar and repeated the observations, but no difference was found.

I took occasion, also, to measure the inductance and resistance of the electromagnet. These were approximately—

0.33 henry with 0.06 amp. (just enough to work it)
0.29 „ „ 0.11 amp.

and 30 ohms. Hence the time constant is at most 0.11 sec., and was sometimes reduced to 0.04 sec. by inserting resistance.

Traces of the action of the electromagnet were then taken on the tape and examined with a microscope. These form an interesting subject of study in themselves. They agreed in their general characteristics with the expectations based on the time constant and the period of immersion of the pendulum, *e.g.*, using 4 volts 0.10 ampere 20 mm. semiamplitude, and a cup 7 mm. in diameter, the calculated latent period required for current to become large enough to attract the armature of the magnet is about 0.008^s; the time occupied by the forward movement of the armature was 0.008^s; it was stationary for

Ampl. mm.	Coincidence. Previous odd second. H.	M.	S.	Tenths of two seconds over.	Coincidence period.	Mean of 4.	Pendulum period.	Ampl. Corr.	Corrected period.
45	13	45	49	0					
		47	25	0	96·0				
		48	59	7	95·4	95·50	0·98964	—7	0·98957
		50	35	4	95·4	·25	61	7	54
		52	11	0	95·2	·05	59	6	53
30		53	45	5	95·0	94·85	57	5	52
		55	19	8	94·6	·65	55	4	51
		56	55	1	94·6	·45	52	3	51
		58	29	3	94·4	·35	51	3	48
	14	00	03	4	94·2	·20	50	2	48
		01	37	5	94·2	·05	48	2	46
		03	11	5	94·0	93·90	46	2	44
		04	45	4	93·8	·75	45	2	43
		06	19	2	93·6	·70	44	1	43
		07	53	0	93·6	·50	42	1	41
14		09	25	9	93·8	·40	41	1	40
		10	59	4	93·0	·30	40	1	39
		12	33	0	93·2	·15	38	1	37
		14	05	6	93·2	·10	37	1	36
		15	39	2	93·2	·15	38	1	37
10		17	11	6	92·8	92·95	36	0	36
		18	45	3	93·4	·80	34	0	34
		20	17	5	92·4	·85	35	0	35
		21	49	8	92·6	·50	30	0	30
		23	23	3	93·0				
7		24	55	3	92·0				

0.065^s, and the spring caused it to return in 0.011^s. Whilst the whole time of passage through the cup should be 0.056^s. The amplitude is small in this instance. By increasing it the stationary period can be reduced till it disappears altogether; but to do this the amplitude must be made to exceed the value commonly used in the experiments. So there seems little prospect of an explanation, on those lines, of the change in period.

Subsequently I attached a small mirror to the Kater pendulum, and observed its vibrations by the usual coincidence apparatus belonging to a set of Sterneck pendulums. In this way the mercury cup was dispensed with, though there was, of course, still an electromagnet—that of the Sterneck apparatus. The curious change in the apparent period was still present. The following is a typical set of observations:—

August 28th, 1912.—Steel pendulum swinging from knife edge "B." Heavy weight above. Observations by Sterneck apparatus, worked by Carroll chronometer—the latter about one hour after winding. Observations by "descending" coincidences only, taken at whole odd seconds. Distance of amplitude scale from knife edge, 1120 mm.

Sir J. J. Thomson on Transmutation.—In a recent number of *Nature*, Prof. Sir J. J. Thomson, writing "on the appearance of helium and neon in vacuum tubes," questions the conclusions arrived at by Sir William Ramsay, Prof. J. Norman Collie, and Mr. Patterson with regard to the supposed synthesis of helium and neon. Sir Joseph Thomson records some of his own experiments which, he says, have led him to a different conclusion. These experiments were undertaken in order to investigate the origin and properties of a new gas of atomic weight 3, which he had discovered, and which he calls X_3. Their object was to ascertain the circumstances which favour the production of the gas, and the possibliity of its being triatomic hydrogen. He found that under circumstances similar to those recorded before the Chemical Society, the appearance of helium and neon was accompanied by larger quantities of X_3. The method which gave X_3, and also the other gases, in greatest abundance, was that of bombarding metals, or, indeed, almost any substance, with cathode rays. From platinum he obtained the most abundant supply of X_3, but the latter gas was also obtained by a similar treatment of lead, and in both instances was accompanied by appreciable quantities of helium and neon. The presence of helium in Sir William Ramsay's old Röntgen-Ray bulbs Sir Joseph ascribed to the helium, thus liberated by the cathode rays, either adhering to the surface, or being absorbed in a much looser way than before its liberation. The question was: how did these gases get into the metal? It was suggested that their presence may be accounted for by partially abortive attempts on the part of ordinary metals to imitate radio-active substances. In the latter the α-particles are emitted with such velocity that they get clear away from the atom, but in the experiments recorded by Sir Joseph Thomson they have not sufficient energy to get clear, but cling to the outer parts of the atom, and have to be helped to escape by bombardment with the cathode rays. The conclusion, in brief, is that the gases are present in the metal quite independently of the bombardment, and that the action of the cathode rays is merely to eliminate them.

THE UNIVERSAL RACES CONGRESS

By Mrs. Julia F. Solly.

On a former occasion* I sketched the design of the Universal Races Congress, which took place in London at the end of July, 1911. Now that the Congress is an accomplished fact, I venture to lay before you some of the results, positive and negative, both as found in the printed reports and in the personal reports of South Africans who were present.

The mechanical arrangements for the Congress were hardly commensurate with its inception and intellectual and spiritual significance; the meeting hall was unsuitable, the reporting poor, and discussion limited and arbitrary. It was perhaps natural at such a gathering that the wearer of a picturesque costume or a dark skin should be preferred to the common or garden Englishman (who, after all, is there all the time), but that the Hon. W. P. Schreiner had no opportunity for speaking on South Africa, while a lady resident here for a few years was allowed to discourse at length, seems amazing, as also the fact that it was with great difficulty that representatives from this country were allowed to contradict definite mis-statements or incorrect inferences.

These minor details apart, all present agreed that it was a remarkable achievement, and all interested in the idea of the Congress, "to encourage a further understanding, the most friendly feelings, and a heartier co-operation between all races," look forward to the next meeting, which is planned for 1914.

The book published before the Congress, entitled "Inter Racial Problems," should be in every public Library, and it is still procurable by those who did not secure it before the Congress. Over 1,000 people scattered all over the world obtained it, and even a most cursory study of the book should dissipate at once and for ever the idea that the colour of the skin affects the ability of the brain, or, in the words of one of the resolutions, "that difference in civilisation does not necessarily connote either inferiority or superiority." In a newspaper article the other day the same idea appeared more colloquially in a warning to the Caucasian not to confuse swelled head with a large brain.

It will surprise no one who has read "The Souls of Black Folk" to hear that the most striking and attractive personality present was Professor du Bois, of Atlanta University; a man be it remembered who, in some of the United States of America, has to ride in a "Jim Crow" car: so far have some of the American citizens forgotten the words of their grand Declaration that promised to all, equal opportunities; and we do well to note it now, when this very point of railway travelling seems agitating some of our own people. The resolution that immediately appeals to a Society like this is the third, which is anticipated by the work of this section and acted on by some of its

* Report S.A. Ass. for Adv. of Science, Bulawayo, 1911, pp. 128-32.

members: To induce each people to study sympathetically the customs and civilisations of other peoples, since even the lowliest civilisations have much to teach, since every civilisation should be reverenced as having deep historic roots. Papers on these lines seem to me most valuable in connection with the Inter-racial problems because least disputable, though the whole question is one that in this country cannot remain academic.

Among the patrons of the Congress were the leading anthropologists of the world, members of nearly every known religious body, and the official representatives of twenty Governments. Though the British Government was not officially represented, the Prime Minister wrote, "this refusal must not be taken to imply that the Government do not sympathise with the objects of the Congress."

A record of the proceedings has been published in which the various and varied resolutions are to be found (for the original plan of passing no resolutions was abandoned), and a permanent League is being formed, to which it is most desirable that scientific bodies should belong, for, whereas political work is necessarily temporary, scientific work is permanent, aiming only, as science does, to get at truth.

On the question of the value of religious propaganda I take the following from Professor Caldecot's speech:—

"Religious propaganda was a recognition of the principle of the unity of the human race. Religion was a matter of persuasion, sentiment, and social order, and could not be associated with force. 'Compulsory religion' were mutually exclusive terms. No Government should include in its programme, propaganda, and its own religion . . . No Governnment should refuse its subjects the right to hear and consider religious messages."

Quite recently a Commission in this country testified to the value of missionary effort; more recently still General Beyers did the same in Cape Town, at a meeting presided over by the Archbishop of Cape Town. This, again, is not the view of the man in the street, whose voice is everywhere to be heard, but it is eminently reasonable. In Mr. Evans's book, "Black and White in South-East Africa," this and kindred questions are carefully considered from the point of view of a resident in Natal, who was also a member of the Universal Races Congress.

Something might be done by this Association to further the fifth and ninth resolutions, which run:

(5) "To study impartially the physical and social effects of race-blending . . . and to discourage hasty and crude generalisations."

(9) "To collect records of experiments showing the successful up-lifting of relatively backward peoples by humane methods."

One may conclude with Sir Sidney Ollivier's words at the Universal Races Congress:

"The modern conscience which aims at international solidarity and the recognition of the rights of nations, is at least as old as the Christian religion, the Buddhist religion and the Chinese philosophy. We are more aware of it to-day because of the modern possibility of international exchange of ideas and ideals."

Gigantic Reptiles from the Cape Province.—In 1909 Drs. W. Janensch and E. Hennig landed at Linde, on the east coast of Africa, to investigate the occurrence of gigantic reptilian bones which had been discovered by Herr B. Sattler, at Tendagura, some three days' march from the coast. For two years they were busy digging, uncovering about forty skeletons of reptiles. Some of these were larger than the famous *Diplodocus* from the North American Prairies, with a humerus 6ft. 6 in. long, and a neck 40 feet in length. Others were not larger than a pointer dog, but nearly all were entirely new varieties of animals. In looking up the literature, Dr. Hennig came across a notice of the late Dr. W. G. Atherstone's, on his find of what he called *Iguanodon* bones on the Bushman's River, some 35 miles south-west of Grahamstown. The account was published in the first volume of the *Eastern Province Magazine*, dated 1857, and the skull was subsequently described by Sir Richard Owen as that of *Anthodon serrarius*. Dr. Hennig accordingly wrote to Prof. Schwarz, of the Rhodes University College, asking him to go down to the Bushman's River and investigate, and during the last Whitsuntide holidays he did so, taking his students with him. The result has exceeded expectations; at the end of the first day the thigh bone of one of the reptiles was discovered in the red Cretaceous marls from which Dr. Atherstone obtained his *Anthodon*, and later on parts of other animals were unearthed. The first bone is the femur of a reptile quite as large as *Diplodocus*. The shaft of the bone had splintered away as is usual in these remains when they lie near the surface, because the bones have exceedingly thin walls, and in life were cavernous and filled with air, thus enabling the beasts to support their gigantic bulk. The two ends of the bone, however, indicate that it was originally some five feet in length, and that the animal to which it belonged was undoubtedly the largest that ever lived in South Africa.

A properly-equipped expedition will shortly proceed to the place and endeavour to excavate more of this extraordinary beast. It is interesting in this connection to remember that the natives in Rhodesia have a legend that animals of the Dinosaur type are still living in their country, and white men have actually seen their foot-prints.

Near the "Iguanodon Kloof," as Dr. Atherstone called the place where his *Anthodon* was discovered, there is a very remarkable cave; the Alum cave. It is excavated between the Enon Conglomerate and the underlying Witteberg beds, and the alum forms in crevices in the shale on the unconformity. The alum is known as Bushmanite, from its occurrence at this particular place, and is a variety of the manganese alum Apjohnite. It is often mistaken for asbestos.

TRANSACTIONS OF SOCIETIES.

Royal Society of South Africa.—Wednesday, April 16th: L. Peringuey, D.Sc., F.E.S., F.Z.S., President, in the chair.—"A new species of *Hæmatoxylon*"; Miss E. L. **Stephens.** The genus *Haematoxylon* has hitherto been represented in South Africa by only one species—*H. campechcanum* L. (the logwood tree). The species now described was found by Prof. Pearson in Great Namaqualand in 1909. It differs from *H. campechcanum* in its shrubby habit, its pilose and glandular young parts and inflorescence, its bilabiate calyx, and its longer petals and stamens. It yields the characteristic logwood dye.—"Notes on the pollination of some South African cycads": Dr. G. **Rattray.** *Encephalartos Altensteinii* Lehm. is pollinated by insect agency, the pollen bearer being a weevil belonging to the genus *Phlœophagus.* Anemophily may still occasionally occur in this species. *E. villosus* Lehm., from its habitat and cone structure appears to be exclusively entomophilous In *Stangeria Katzeri* Rgl., no evidence of entomophily has been found.—"A synopsis of the species of *Lotononis* and *Pleiospora*": R. A. **Dummer.**—"Note on an overlooked theorem regarding the product of two determinants of different orders": Dr. T. **Muir.**—"Note on the Newcomb operators used in the development of the perturbative function": R. T. A. **Innes.**

Geological Society of South Africa.—Monday, March 17th: A. L. Hall, B.A., F.G.S., President, in the chair.—"Notes on the Sea Point granite-slate quartzite": Prof E H. L. **Schwarz.** From the point of view of historical geology, the granite-slate contact at Sea Point, first described by Clark Abel in 1818, is one of the most famous exposures in the world. There may be said to be five zones of injection intrusion and contact phenomena, with intervals of apparently unaltered rock, the fifth, or outermost zone being about three-quarters of a mile north-east of the main contact. Felspar crystals impregnate the rock for the first time at the third zone, about 500 yards from the outermost contact. The main zone exhibits a gradation of slate into granite. The substance of the granite has in some instances advanced by the process of solution and deposition through the agency of water: in others large masses have been injected under pressure, in proof whereof an extraordinary case of concertina folding in a quartz vein pre-existent in a slate block included in the granite was cited.—"Notes on diamonds in the Banket": Dr. R. B. **Young.** Diamonds have at various times been found in the mortar boxes of certain of the Rand Mines. The colour of these stones, when recorded, has invariably been green. It is considered that the diamonds were deposited with the pebbles during sedimentation, and their occurrence shows that a source of diamonds exists in the pre-Witwatersrand rocks from which the banket was derived.

NEW BOOKS.

Crawford, D.—*Thinking black: twenty-two years without a break in the long grass of Central Africa.* 8vo., pp. xvi, 504. Maps and illus. London: Morgan and Scott, 1912. 40 oz., 7s. 6d.

Powell, E. A.—*The last frontier: The white man's war for civilization in Africa.* 8vo., pp, xv, 291. Maps and illus. London: Longmans, Green & Co., 1913. 32 oz., 10s. 6d.

Thompson, W. W.—*Sea fisheries of the Cape Colony.* pp. viii, 163. Cape Town and Pretoria: T. Maskew Miller, 1913. 12 oz.

Engler, A.—*Die Pflanzenwelt Afrikas insbesondere seiner tropische Gebiete.* Band 1, Hälfte 1, 10½in. x 7½in., pp. xxviii, 478. Hälfte 2, pp. xii, 479—1029. Maps, illus. Leipzig: W. Engelmann. 1910.

Leclercq, Jules.—*Aux sources du Nil par le Chemin de Fer de l'Ouganda.* 7½in. x 5in., pp. v, 295. Maps, illus. Paris: Plon-Nouritt et Cie, 1913.

Cranworth, Lord.—*A colony in the making; or, sport and profit in British East Africa.* 9in. x 6in., pp. xiv, 359. Maps, illus. London: Macmillan and Co., 1912.

Darmstaedter, P.—*Geschichte der Aufteilung und Kolonisation Afrikas seit dem Zeitalter des Entdeckungen.* Band 1, 1415-1870. 9½in. x 6in., pp. viii, 320. Maps. Berlin: G. J. Goschen., 1913. 7 *M.* 50 *pf.*

THE SOUTH AFRICAN NATIONAL DEBT.

By Prof. Robert A. Lehfeldt, B.A., D.Sc.

The history of the South African national debt begins with a loan of £12,500 authorised in 1852 for works at the Kowie Harbour; an unfortunate start in public works, but one that has been made up for since. At the present date—sixty years later—the total debt is well over one hundred millions, most of which is represented by substantial assets, such as railways and harbours. The earliest loans, both of Cape Colony and of Natal, were made at six per cent., from which the rate fell steadily till in the exceptional period at the end of last century it nearly reached three per cent: since when it has risen. The change in this respect may be analysed into two parts, that due to world-wide fluctuations in the rate of interest, and the special insurance premium charged to the Colonies when their financial reputation was still new. Fortunately the early loans, at high rates, have been so outgrown by the steady advance of the Colony in wealth that they are no appreciable burden. The bulk of the debt is comparatively recent, and was contracted at moderate rates of interest.

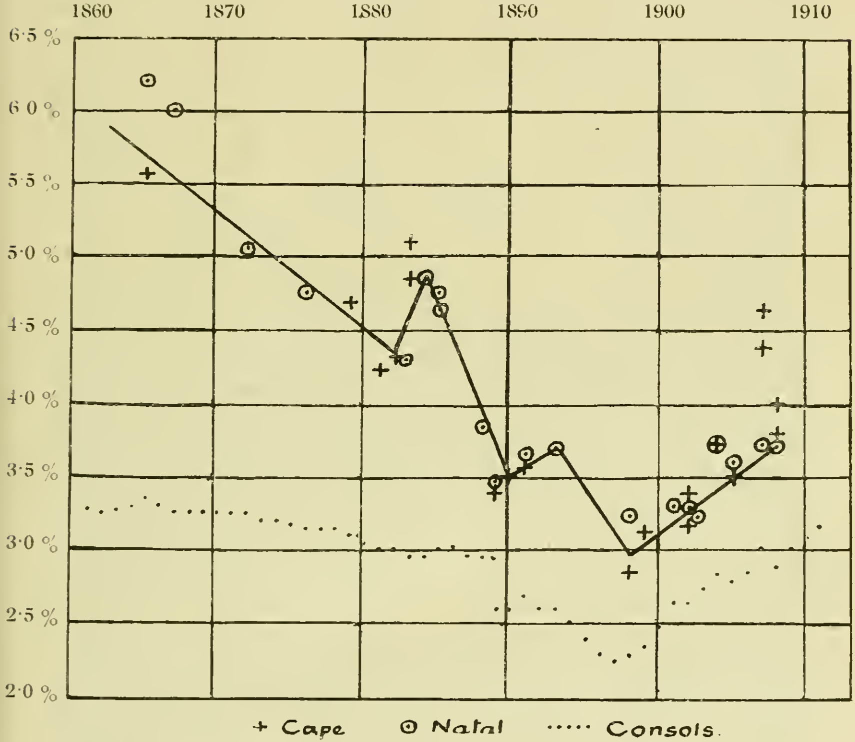
In estimating the rate of interest it is, of course, necessary to take into account the price actually paid by lenders for the stock, and the redemption rights attached to the loan—*e.g.*, in November, 1893, Natal issued some 3½ per cent. stock at an average price of £9,527 per £10,000 stock; this gives a yield of 3.67 per cent. per annum. But as the Government is bound to repay the stock in full not later than 1939 the holder will receive a bonus of £473 per £10,000 stock. This is equivalent to being paid 0.04 per cent. interest during the currency of the loan. The total yield to the investor is therefore 3.71 per cent. The interest paid by the Government of Natal is another thing, however, for the Government did not receive the £9,527 paid by the lender, a part being absorbed in expenses. In the older loans it is often difficult to disentangle this amount. Of late years public accounts state the matter quite clearly, and in the Cape Blue-books the net interest paid on certain recent loans has been stated in the most forcible manner. Expenses of flotation consist of the British Government tax, brokerage, and underwriting charges. This money, of course, goes to London, at the cost of the Colonial borrower; and of late it has averaged 2½ to 2¾ per cent. of the total money received by the borrower. The result is to make the true interest as paid by the Government from 0.10 to 0.15 per cent. higher than that received by the investor.

If a diagram be drawn giving the interest paid on all the successive loans, the trend of the rate of interest is very clearly seen. (It is no use trying to draw such curves with too great accuracy, as the true meaning would then be obscured by accidental variations.) The credit of the Cape and Natal has been

TABLE A.

	Reference Letter.	Cape Colony.	Natal.		Consols.	Diff.
		Yield to the Investor				
1865 ..	J	5·57	..	..	3 35	2 2
1865 ..	O	..	6·20	..	3·35	2·9
1867 ..	O	..	6 00	..	3·25	2 7
1872 ..	Q	..	5·05	..	3·25	1·8
1876 ..	R	..	4 76	..	3·15	1·6
1879 ..	L	4·70	..	..	3·10	1·6
June, 1881 .	M	4·23	..	..	3·00	1·2
June, 1882 ..	N	4 32	..	..	3·00	1 3
Nov., 1882 ..	S	..	4 31	..	3·00	1·3
Dec., 1883 ..	O	5·10	..	Ten year Bonds.	2·95	
Dec., 1883 ..	P	4 85	..	..	2·95	1·9
Mar., 1884 ..	U	..	4·87	Ten year Bonds.	2 95	
July, 1885 ..	V	..	4 77	do.	3 00	
July, 1885	T		4 64	..	3 00	1 6
Feb., 1888 .	W	..	3 85	..	2·95	0·90
Jan., 1889 ..	Q	3 41	..	..	2·60	0·75
May, 1889 ..	X	..	3·48	..	2 60	0·85
Mar , 1890 ..	R	3·50	..	..	2·60	0·85
Jan., 1891 ..	R	3 57	..	..	2·70	0·85
Jan., 1891 ..	X	..	3·68	..	2·70	0 90
Nov., 1893 ..	X	..	3 71	..	2·60	1·10
Jan., 1898	U	2 86	..	..	2 30	0 55
Dec., 1898 ..	Y	..	3·24	..	2 30	0 95
Mar., 1899 ..	U	3 12	..	..	2·35	0 75
May, 1901 ..	Y·	..	3·31	..	2 65	0 65
Jan., 1902 ..	Y	..	3·30	..	2 65	0·65
Jan., 1902 ..	R	3·40	..	..	..	0 75
June, 1902 ..	U	3·18		..	..	0 55
Nov., 1902 ..	Y	..	3 25	..	..	0·60
April, 1904 ..	Z	..	3·73	..	2 85	0·90
June, 1904 .	R	3·73	3·73	..	..	0·90
Dec., 1904 ..	Z	..	..	..	..	0·90
Feb., 1905 ..	R	3·59	..	..	2·80	0·80
July, 1905 ..	Z	..	3·61	..	..	0·80
Jan., 1907 ..	R	3·73	..	..	3·00	0 75
Jan., 1907 ..	Z	..	3·73	..	..	0·75
May, 1907 ..	V	4·41	..	Four year Bonds.	..	
Dec , 1907 ..	W	4·64	..	Ten year Bonds.	..	
Jan., 1908 ..	R	3·81	..	..	2 90	0·90
Aug., 1908 ..	Z	..	3·72	..	2·90	0·80
Sept., 1908 ..	X	4 00	..	Colonial Issue.	..	
				Average, 1888—1908	..	0 80
May, 1903 ..	Transvaal Guaranteed 3·00			..	2·75	0 25
June, 1904 ..	do. 3 05			..	2 85	0·20
Jan., 1909 ..	do. 3 15			..	3·00	0·15
April, 1913 ..	Union of S. Africa 4 00			..	3·35	0·65

so closely the same that a single table ("Table A") has been made of the two. In this are given the yields on all the more important issues made by these Colonies (excluding Treasury bills). For comparison the contemporary yield on Consols is given. This is not perfect, as a guide to the international rate of interest, but it is the best obtainable at present. The final column shows how much more the Colonies paid than Consols were yielding at the time, and is a guide to the credit of those Colonies. Fig. 1 is drawn from these numbers. It will be seen that the Colonies improved in credit (with one set-back about



1883) until 1888, since when there has been no noticeable change. For the last twenty years Cape Colony and Natal have paid an average of 0.80 per cent. more than the yield on Consols. (In this calculation short loans have been omitted, as misleading.) This is not quite an accurate test, because the British Government has been repaying debt for the most part; if it came to borrow no doubt Consols would fall in price, and their yield rise. As evidence of this may be taken the Transvaal loans guaranteed by Britain. These were issued in 1903 and 1909 at rates 0.25 and 0.15 higher than the current yield on Consols. Taking the mean 0.2 and deducting from the figure given above, we may perhaps say that the late Governments of Cape Colony and Natal had to pay 0.6 per cent. more than that of Great Britain, for loans. The Union Government, if it adopts a wise policy, should do a little better.

It may be added that towards the end of its career the Government of Cape Colony grew somewhat reckless, and raised money on short loans at excessive rates—the London market, it was supposed, becoming somewhat shy of the Cape as a borrower. Mr. Merriman becoming Premier, and finding it still impossible to do without a loan, raised one very successfully in Cape Colony itself. Before that date there had been several small local loans, and some considerable issues of Cape 3½ per cent. in 1892-3-4, and 3 per cent. in 1894 and 1900, but a good deal of this stock had been transferred gradually to the London register. Mr. Merriman's loan in 1908, though appearing in the table as at a higher rate of interest than the preceding long date loans, was really at almost the same rate, on account of the saving in expenses of issue. Thus the loan of January, 1908, cost the Cape Government 3.97 per cent., that of September only a trifle over 4 per cent., and probably it would not have been possible, then, to get a loan floated in London at even the price of January.

A curious point of psychology appears in these figures, and is, I think, confirmed elsewhere. Sometimes a borrower is in doubt between two nominal rates of interest—*e.g.*, in 1902 the Cape Government could get a premium on 3½ per cent. stock, but had to allow a discount on 3 per cent. Logically the prices ought to be adjusted so that, allowing for redemption, the yields should be the same. But practically lenders like to get a discount, and will not give a high enough premium. It is, therefore, cheaper for the borrower to choose the lower nominal rate. Thus in January, 1902, the Government had to pay 3.40 per cent. on three-and-a-halfs, although in June of that year, when credit conditions were no better, it was still able to raise money on three per cent. stock at 3.18 per cent.

The earlier loans were in the form of debentures to bearer; but for many years now inscribed or registered stock has been preferred. Lately the home market has shown an inclination for bearer securities, so that it may become advantageous to re-adopt that form. The question depends largely on the treatment the Home and Colonial authorities give to these different securities in the matter of taxation. The laws as to taxation of securities that are held internationally are becoming so confused that it is to be hoped an international conference may be held on the subject before long.

All the South African Governments have adopted the sound plan of promising to repay their loans at fixed dates, in no case exceeding fifty years ahead. The only exception is in some early issues of Cape stock, at 5 and 4½ per cent. of indefinite currency, and of these only three-quarters of a million are now outstanding. It is true that when loans fall due, fresh loans are usually contracted to meet them; but there is nothing wrong in this, and the policy of repayment keeps the value of stocks from falling much below par, and enhances the credit of the borrowing Government.

Most of the early loans were provided with a definite sinking fund, for the use of that particular loan—commonly 1 per cent. With the improvement in credit, this plan was dropped, and a general sinking fund instituted instead, and sometimes this too has been dropped. It is now unnecessary for the security of lenders, as they accept unreservedly the Government's promise to repay at a fixed date. But for the sake of the Colony itself it is most desirable to carry out a definite policy of repayment. This is dealt with further below.

The problem of continuing or converting old loans when they become redeemable is one that Colonial treasurers have had to meet before now, and which will recur continually. Up to the present such conversions have been accomplished with a saving of interest, as the credit of the Colonies has improved. Thus all the early six per cent. and nearly all of the five per cent. loans have been wiped out. Mostly the Government has not waited till the loan has become due to convert it. In some cases there was an option to redeem at an earlier date; in others the Government has offered new stock on terms sufficiently tempting to induce lenders to exchange. It will be instructive to note the effect of one or two typical conversions.

The first large loan by Natal was an issue in 1876 of £1,200,000 $4\frac{1}{2}$ per cent. bonds redeemable by sinking fund not later than 1919. The price of issue was $95\frac{1}{2}$, giving a yield (including redemption rights) to the investor of 4.76 per cent. Eleven years later about half of these bonds were exchanged for four per cent. consolidated stock, due 1937, at the rate of £106 stock for each £100 bond. In this case there was no right of compulsory redemption, so the Government had to offer this premium. This gives a yield of 4.48 per cent.—a saving of 0.28 per cent. it is true, but then the Government has to pay it for eighteen years longer. If it had waited till the loan fell due, it could presumably have renewed it for less than four per cent. (the present rate on new loans is about $3\frac{3}{4}$). By 1937 it would probably be in a better position if it had not converted than it will be actually. The advantage of conversion in this case is quite illusory; and so it usually is when investors have to be tempted by a premium.

A different case was that of the Natal loan of March, 1884. This, issued in a time of temporary stringency, was in the form of 5 per cent. bonds, but they were redeemable in ten years at least or forty at most. ("Ten-forty bonds.") The yield to the investor was 4.87 per cent. As soon as, in 1894, they became redeemable, the Government took advantage of the extraordinary cheapness of money to convert all that were still outstanding, into three and a half per cent. stock due 1914 to 1939, and this was actually effected with a reduction of capital, so that the yield to the investor was reduced to 3.37 per cent. This was a large saving to the Government, but, of course, it only meant that for ten years Natal had been paying an unusually high rate of interest, which was reduced after that period to the contemporary normal rate. It remains, however, a valuable resource in times of difficulty to issue short date bonds, and convert as soon as possible. It was in this way that Japan financed the great war with Russia.

It is, of course, clear that opportunity for a saving by conversion only exists when the conditions of credit have become more favourable than they were at the date of issue of the loan to be converted. But this may be due to either or both of two causes—(i.) an improvement in the credit of the individual borrower (*ie.*, a reduction in the insurance premium charged against him) or (ii.) a fall in the international rate of interest. Both these causes helped to bring about one or two favourable conversions towards the end of the last century, but with regard to (i.) Table A shows that the possibility of it nearly ceased about 1888. For the twenty-two years from that date to the extinction of the Cape and Natal Governments, their credit showed no improvement; and though the Union Government may in time occupy a slightly more favourable position the margin for improvement is small, and it is doubtful enough whether any improvement will be brought about. There is still a large amount of four per cents., issued before that date, which will become redeemable in the next fifteen years, and probably a saving will be accomplished when they are converted. But after that there is no prospect of economies due to enhanced individual credit.

The problem of conversion then becomes identical with that occurring in old countries such as England. It depends on the fluctuation of interest in the international markets. It is well known that this rate fell off in recent times to about 1896, and has risen since. The subject has been discussed elsewhere*, and it is not necessary to repeat the arguments here. It need only be remarked that the belief, formerly so general, and even now widely held, that the rate of interest falls steadily with the progress of industrial civilisation, is not true. The rate varies on account of several causes, of which the most important is the rate of gold production, and it is just as likely to rise as to fall in the future. Colonial Governments, therefore, cannot rely upon effecting economies in interest by conversion after their credit has become well established and the early loans are repaid: that is, in the case of South Africa, after a few years hence.

The deduction just reached makes it all the more necessary to consider the right policy with regard to payment for public works carried out by means of loans. It is recognised that the present generation cannot be expected to pay for extensive per-

* Lehfeldt. "Public Loans." (*Economic Journal*, March, 1912).

manent improvements, especially in new countries, where the burden is reduced by being postponed. On the other hand, it is not fair to throw all the cost on posterity, by borrowing the money and making no provision for repayment. A sound intermediate course is to spread the payment over a number of years, according to the estimated durability of the improvements. Accordingly borrowers have been required to provide, in addition to interest, a sinking fund, calculated to extinguish the debt in some such period as 40 to 60 years. This rule has been adopted regularly in the case of municipalities, which, of course, are not sovereign, and often by sovereign States desirous of establishing a good reputation in the money market. Unfortunately a borrower—as was discovered in the case of the British Government more than a century ago—may be driven to borrow at the same time as he is paying into the sinking fund, and the latter then becomes an illusory security. Even a municipality, which may be compelled, by law, to maintain a sinking fund, or to repay at a fixed date, is sure to need new works, and so has an excellent excuse for renewing each loan when it falls due. It cannot be said, therefore, that the sinking fund method is an adequate guarantee that the present generation will pay a fair share of the cost of public works it undertakes, and it seems to me that some other plan is demanded in the interest of sound finance.

Even the improvements that are called permanent are not really so. Most of the South African debt has gone into the "permanent works" of the railways. There is a charge for maintenance of these, it is true, but even when maintained in good condition they may be subject to depreciation. Buildings grow out of date and inconvenient, bridges inadequate, and so on: the whole railway system may conceivably be rendered antiquated by the progress of invention. The same is true of harbour and irrigation works. There is only one kind of property whose value can be trusted as permanent, and that is land itself. Apart from the actual value of the sites of public works, it is not safe to accumulate a public debt and hand it on by successive conversions indefinitely to posterity. Probably sixty years is a fair limit to take for the duration of any improvements. But the question is how to be sure that they will be paid for in this period, and be kept free from the jugglery of necessitous finance ministers.

The solution I venture to propose is this: *That when any work is undertaken, a fraction of the cost (other than for the acquisition of land) sufficient, if accumulated for 60 years, to equal the whole, should be paid for out of revenue.* If interest be taken at $3\frac{1}{2}$ per cent., this fraction is one-eighth, at 3 per cent. one-sixth. The rule would mean then, that if the Government wished to construct new railways or rather long-date works, it should first estimate on a sound and conservative basis the cost of the land. This might be borrowed. Next, the cost of the improvements should be estimated, and of this one-eighth must be paid out of current revenue; the remaining seven-eighths might be borrowed; and there would be no special obligation to repay either of the amounts raised on loan. This does not mean that the bonds issued should be of indefinite currency. For other reasons, already mentioned, Colonial Governments should stick to the plan of borowing by means of bonds or stock for, say, 30-40 years. But it means that the loans so maturing should be renewed, as a matter of course, on the best terms the market offers.

The effect of carrying out this policy in a progressive community for a long period would be equivalent to that of a sinking fund, which cannot be tampered with; for the debt will be kept steadily down to the value of the property acquired with it, whilst present conditions of progress endure. Fortunately for us, this policy has been followed out to some extent. Thus the capital value of the railways is stated as 86 millions, of which only 73 millions are now owing, the remainder having either been paid out of income, or borrowed and repaid out of subsequent income; and a controversy arose, recently, between the Railway Department and the Treasury as to which of these sums the railways should be required to pay interest on. There is, however, no rule requiring the provision of a part of the cost out of revenue, and it is likely that when loans fall due they will be renewed, whether the renewal has been justified by previous expenditure out of revenue or not. The contention of this article is that it should become a legal obligation to provide one-sixth or one-eighth of the cost (other than of land) from revenue—a larger fraction, of course, if the improvement is of shorter date.

Some of the debt has been incurred to meet deficits. This stands on an entirely different footing, and ought to be repaid. But so far as the policy of public works is concerned, the adoption of the present proposal would put the country on a sound financial basis.

It must be understood that this solution is one proposed for, and is only applicable to, new countries whilst expanding considerably; that is to countries like South Africa in its present phase. In existing circumstances, a sinking fund, if such were established by law, would be ineffective, for the colony would undoubtedly go on borrowing faster than it repaid; and this consideration has influenced the Government, for, actually, sinking funds have long been abandoned. No Cape loan since 1882 and no Natal loan since 1884 has been provided with a special sinking fund; the Transvaal loans have, but that is on account of the guarantees of the British Government, which, of course, does not intend to make itself responsible for Transvaal debt after the present issues have been paid off in 30 or 40 years from now. With that exception, the creditors of South Africa are content with the general promise to devote surpluses to paying off debt. The latter provision should be maintained in any case, as it is effective in years of plenty. The proposal should not, however, be judged by comparison with a systematic sinking fund of a fixed percentage of the debt, for such a thing does not exist here; and the chances are that in the absence of any definite policy debt will be allowed to accumulate in excess of the value of the works it is supposed to represent. What is needed is a safeguard against too rapid accumulation of debt during the progressive stage of the country. When a more stationary condition is reached, such as that of England now, in which public works are not so urgent, the problem of reducing debt must be faced, and the solution here proposed will not be applicable. But this generation will not see that state of things, and we are discussing what should be done here and now.

To illustrate the effect of the policy, suppose that this year South Africa needs to borrow a million for railways, etc.; but, as population, industries, and needs are constantly growing—we will say at the rate of 2½ per cent. per annum—the next year £1,025,000 will be needed, and the sum borrowed every year will increase at that rate. (This is in accordance with history. In the sixties, borrowing was on the scale of a hundred thousand; in the eighties, transactions had grown to millions; by the end of the century, tens of millions; and now the total debt is over a hundred millions. The rate of increase assumed is equivalent to doubling in 28 years.) If, further, we suppose interest (over a long period ahead) to average three per cent., and the money to be raised on the sinking fund plan, one-half per cent. being set aside as a sinking fund (this is suitable for public works with a life of 60 years), then in 1962 the outstanding debt would be £83,200,000. If the plan suggested be adopted, one-sixth being paid out of revenue and no debt paid off, the outstanding debt at that date will be £83,000,000. It is, perhaps, difficult to grasp this result, which is due merely to the fact of not having borrowed so much, but it is arrived at by the cold reasoning of mathematics. If the period considered is less than 50 years, the situation created by the proposed method is more favourable —if longer, less favourable; but it must be repeated that the method is not intended as a solution of the problem for all time. On the contrary, by 1962, South Africa will be much richer, and nearer to a stationary condition, and must be expected, then, to begin paying off its debts. More than that, the salutary plan of devoting surplus revenue, when there is no definite call on it, to paying off debt, should be continued, and that will ensure some reduction during times of prosperity. What is aimed at here is a substitute for the illusory plan of a sinking fund—always at the mercy of a needy Finance Minister—running concurrently with new borrowing, or else for no plan at all, as in South Africa at the present time.

It will probably be said that the Government might depart from the system here proposed, after instituting it; just as in the case of a sinking fund. True, there is no system that cannot be abused. But it might be replied: (1) If a Government takes to suspending the sinking fund, it destroys the precaution taken with respect to all past debts; but if it abandon the system of paying part cost out of revenue, it does not do so much harm, as the past expenses are already to some extent provided for. (2) If it were once recognised that good finance demands payment of part cost out of revenue, it would not be easy to depart from the system, for the fault would be glaringly obvious. Any government that said it could not meet the needed expense out of revenue would have to face the retort, "Then don't spend the money." Indeed, the system proposed is more elastic than the sinking fund, for in bad years it is only necessary to stop spending on public works and the demand on the revenue stops automatically without the canons of good finance being infringed. It need hardly be added that the suggested plan is equally applicable to other countries. If it were adopted generally, the loan market would come to expect it, and look askance on loans that were not so safeguarded, and thus a wholesome check would be imposed on governments inclined to extravagance.

APPENDIX.

If a sum m be borrowed at a rate of interest a and a fixed charge of mb per unit time be provided to meet it, then after time n the fraction outstanding, z will be given by

$$\frac{dz}{dn} = -(b-az)$$

$$\Big[n\Big]_0^n = -\int_0^n \frac{dz}{b-az} = \frac{1}{a}\Big[\log(b-az)\Big]_1^z$$

$$an = \log\frac{b-az}{b-a}$$

$$e^{an}(b-a) = b-az$$

$$z = \frac{b-(b-a)\,e^{an}}{a}$$

(a) If a constant sum m_0 be borrowed each unit of time, then the accumulated debt l at the end of time N from the first loan will be

$$l = \int_0^N m_0 z\, dn = m_0\int_0^N \frac{b-(b-a)\,e^{a(N-n)}}{a} =$$

$$\frac{m_0 bn}{a} - \frac{m_0(b-a)}{a}\int e^{a(N-n)}\,dn$$

$$= m_0\left\{\frac{bn}{a} + \frac{b-a}{a^2}\,e^{aN}\left(e^{-aN}-1\right)\right\} = m_0\left\{\frac{bn}{a} - \frac{b-a}{a^2}\left(e^{aN}-1\right)\right\}$$

(β) If a sum $m_0 e^{cn}$ be borrowed each unit of time (where c is a constant) the accumulated debt is

$$l = \int_0^N m_0 e^{cn} z\, dn = \int_0^N m_0 e^{cn} \left\{ \frac{b}{a} - \frac{b-a}{a} e^{a(N-n)} \right\} dn$$

$$= \frac{m_0 b}{ac} (e^{cN} - 1) - \frac{m_0 (b-a) e^{aN}}{a} \int e^{(c-a)n} dn$$

$$= \frac{m_0 b}{ac} (e^{cN} - 1) - \frac{m_0 (b-a) e^{aN}}{a(c-a)} \left[e^{(c-a)n} \right]_0^N$$

$$= \frac{m_0 b}{ac} (e^{cN} - \quad) - \frac{m_0 (b-a)}{a(c-a)} \left\{ e^{cN} - e^{aN} \right\}$$

On the alternative plan the sums borrowed would be

a) $\frac{am_0}{b}$ per unit time, and the accumulated debt, without any sinking fund

$$l' = \frac{am_0 N}{b}$$

or

(β) $\frac{am_0 e^{cn}}{b}$ per unit time, and the accumulated debt

$$l' = \frac{am_0}{b} \int_0^N e^{cn} dn = \frac{am_0}{bc} (e^{cN} - 1)$$

In case β let $a = 0{\cdot}030$ $\quad b = 0{\cdot}035$ $\quad c = 0{\cdot}025$

$m_0 = 1{,}000{,}000$ $\quad n = 50$

Then $l = 83{,}200{,}000$

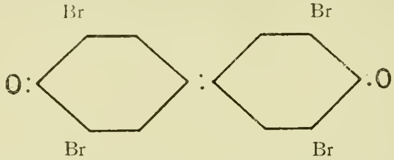
$l' = 83{,}000{,}000$

Agriculture in the Mozambique Province.—An article descriptive of the state of agriculture in the Province of Mozambique, by Mr. R. N. Lyne, lately Director of Agriculture of the Province, appears in the *Bulletin of the Imperial Institute* (Vol. xi, No. 1, pp. 102-110). Although the territory described could afford grazing to a million head of cattle, only five per cent. of that number is carried. Foremost among the growing industries of the country is sugar-cane cultivation. The output of sugar in 1910 was 30,000 tons, and it is anticipated that 1914 will see that figure doubled. The greatest asset which the Province possesses is represented by the Landolphia rubber forests, and their capital value is estimated to approximate 15 million pounds sterling. Of oil-producing plants, *Trichilia emetica*, the source of mafura tallow, and *Telfairia pedata*, whose kernels are rich in oil, flourish at Inhambane. Sisal hemp grows from one end of the Province to the other, and nowhere in East Africa has it such good prospects. Mauritius hemp can be grown over a greater range of latitude, but is unlikely to prove popular. No headway has been made with cotton, and tobacco has not received its due attention.

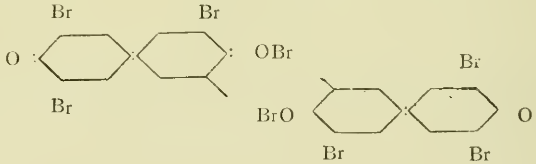
TETRABROMO-DIPHENO-QUINONE.

By James Moir, M.A., D.Sc.

Some of the history of this beautiful and puzzling substance has already been given in a preliminary note written seven years ago.* It forms deep scarlet needles, generally minute, with a blue metallic lustre, and is insoluble in all solvents, although it dissolves sufficiently in the ketonic solvents to colour them orange-red. On heating, it decomposes without melting. Its constitution is analogous to that of coerulignone, but its behaviour differs, inasmuch as part of the bromine, though apparently present in attachment to benzene rings, is remarkably reactive, and thus capable of leaving the rings. Accepting the constitution given by its discoverer, Magatti,† and subsequent workers on dipheno-quinone, its constitution would be—



Its general behaviour, however, suggests an ortho-quinonoid linkage and a higher molecular weight, and the author tentatively suggests that it may be an oxonium bromide of double molecular weight, with part of the bromine displaced so as to be more under the influence of the oxygen than of the ring, thus:—



It is made by oxidising tetrabromo-diphenol with almost any oxidising agent, so long as the solvent is indifferent to oxidation. The author has also discovered that the same substance appears under another name, *viz.*, *bromrosochinon*, having been obtained by Baeyer by oxidising tetrabromo-phenolphthalein with nitro-sulphuric acid. In the same way, the substance described by Baeyer as *bromhydrorosochinon* is really ordinary tetrabromo-diphenol. Baeyer probably missed this discovery by assuming a wrong arrangement of the bromines in the substances (see under), and Beilstein repeats this wrong orientation of the substituents in tetrabromo-phenolphthalein. The bromines are, of course, in the 3 and 5 positions and OH in 4, in all these compounds.

* Proc. Chem. Soc., 1906, p. 110.
† *Berichte*, 1880, p. 225.

A. The starting-material, tetrabromo-diphenol, is made by dissolving purified diphenol (4-4′ dihydroxy-diphenyl) in hot glacial acetic acid, and adding, all at once, a solution of 8½ atomic equivalents of bromine dissolved in warm acetic acid. Tetrabromo-diphenol crystallises out as soon as the evolution of HBr is ended, but the mixture is kept warm for an hour. Thereon sufficient of a saturated solution of Na_2SO_3 is added to decolourise the bromine left (otherwise on dilution some of the quinone is formed), and the mixture then diluted and filtered. After recrystallisation from alcohol, tetrabromo-diphenol melts at 266°. Analysis by my method* gave Br=63.62%. Theory for $C_{12}H_6Br_4O_2$=63.72.

Tetrabromodiphenol-diacetate was made by use of acetic anhydride and potassium acetate. Its melting-point was found to be 247°, rather higher than that found by Magatti. *Tetrabromo-diphenol-dibenzoate* is new. Made by the Schotten-Baumann method. White granules, appreciably soluble in ethyl acetate and acetone only: melting-point 245°. Analysis gave Br=45.62%. Theory for $C_{26}H_{14}O_4Br_4$ =45.07.

What appears to be *tribromo-diphenol* is obtained from the mother-liquors of the tetra-compound when sufficient time for reaction has not been given: m.p. 150°; comparatively soluble; otherwise behaves in the same way as the tetra-compound. Analyses inconsistent, from 55 to 58% Br.

B. *Configuration of tetrabromo-diphenol.*—(1) On digestion with an excess of a mixture of $KClO_3$ and dilute hydrobromic acid, the substance is oxidised to 2-6 dibromo-quinone of melting point 130°, which is also obtained when tetrabromo-diphenol is boiled in benzene with a large excess of PbO_2 (see below for new method of preparing dibromo-quinone); (2) bromine and soda produce small quantities of 2-4-6-tribromo-phenol; (3) oxidation of tetrabromo-diphenol-diacetate with CrO_3 in acetic acid near the boiling-point of the latter, followed by hydrolysis of the acetyl group from the gummy product, gives a sparingly soluble acid, which was identified as 3-5-*dibromo*-4-*oxybenzoic acid.* The specimen, not quite pure, melted at 262°. This substance was discovered by Kerp (see Beilstein), and I have also obtained it by oxidising the diacetate of tetrabromo-phenolphthalein in the same way as above. I also made a quantity of this substance, starting by treating a saturated water solution of paracresol with bromine water, acetylating the 2-6-dibromocresol formed, and oxidising it with CrO_3 as above to change $-CH_3$ into $-CO_2H$: finally the acetylated acid was hydrolysed as before and purified, but I was unable to obtain a higher melting-point than 262°. The acid resembles tetrabromo-diphenol, but gives no colour-reactions on oxidation. On re-acetylating it and recrystallising the product, 3-5-dibromo-4 acetoxy-benzoic acid was obtained in soft white granules, m.p. 187° (not sharp).

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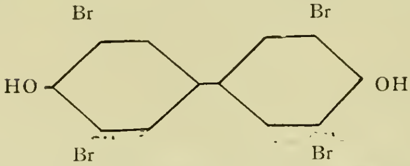
* Proc. Chem. Soc., 1906, p. 263 (and 1907).

From the foregoing evidence tetrabromo-diphenol is—



C. *Methods of preparation of tetrabromo-dipheno-quinone.* —The author has been unable, following Magatti's method (use of fuming nitric acid), to obtain a pure product, although the latter corresponds exactly with Magatti's description (*Ber.* 1880, 226). Seven determinations gave values for Br. varying between 60.8 and 62.5, whereas the theory is 63.97%. Magatti published an analysis giving 64.44% Br., but since he has miscalculated the theory as 64.60, I believe his analysis to have been fictitious. He has contributed also two other miscalculations to Science, namely, the theoretical figures for tetrachloro-diphenol and tetrachloro-dipheno-quinone, which are wrong in nearly all the items.*

My best product is obtained by first dissolving diphenol in caustic soda and reprecipitating with dilute acid. It then forms a remarkable semi-transparent jelly (which becomes opaque on heating). Excess of $FeCl_3$ is then added, when the jelly gradually oxidises, through the dark-olive quinhydrone described below, to the quinone. The mixture is kept at about 50° for eight hours, becoming brick-red and finally microcrystalline; after washing and drying, it is repeatedly extracted with warm alcohol and benzene to remove soluble impurities, such as dibromoquinone. Found C=29.05, H=1.10, Br. =63.0 and 63.9. Theory $C_{12}H_4Br_4O_2$:—C=28.8, H=0.8. Crystals of a less microscopic size are obtained by using dilute HNO_3 and $Fe(NO_3)_3$ for the oxidation: found Br=64.1%.

Fairly large crystals, like those given by Magatti's method, can be got by adding the theoretical quantity of CrO_3 in cold acetic acid to a saturated solution of tetrabromo-diphenol in acetic acid at 50°. At lower temperatures the quinhydrone is obtained, and at higher temperatures the whole is oxidised, apparently to dibromo-quinone.

A fairly pure product is also obtainable by digesting the above-mentioned jelly with 50% nitric acid until the product is red with a violet lustre, washing with a large quantity of dilute ammonia to remove nitro-compounds, and then with warm alcohol and finally with water. It should not be dried in presence of alcohol. Other methods giving apparently satisfactory products (but with Br 1% low) consist in heating the acid jelly (1) with aqueous CrO_3 and a little $FeCl_3$, (2) with gradual addition of $KBr+KBrO_3$.

All attempts to perform the synthesis of this substance from

* For examples of other fictitious German analyses the interested reader should consult *Trans. Chem. Soc.*, 1900, p. 632.

the single benzene-ring (see coerulignone and Auwers and Markovits, *Berichte*, 1905, 226), *viz.*, from 2-6 dibromophenol, failed at first. A small quantity has, however, been obtained as follows:—The starting material is made by distilling tetrabromo-phenol-phthalein with 70% H_4SO_2. It was dissolved in a large quantity of cold water, treated with $FeCl_3$, and the mixture nearly neutralised with $NaHCO_3$: it must never become alkaline. Thereon it is slightly warmed and the neutralisation completed by adding K_2CrO_4 until a trace of iron is precipitated, then filtered and kept at 70-80° for an hour. The precipitate is extracted with excess cold dilute HCl until free from iron, and dried and the soluble bye-products removed by means of ether. The small residue then gives the H_2SO_4, and the NaOH reactions for tetrabromodipheno-quinone. A similar result is given by oxidation in 50% acetic acid with CrO_3, the yield being tiny.

Tetrabromo-diphenoquinone does not dissolve sufficiently for recrystallisation in any solvent: at most 1 part in 2,000 of acetone, benzene or ethylacetate can be dissolved. It dissolves in sulphuric acid to an intense crimson solution, which enables it to be detected in traces. It does not melt, but on heating to 200° evolves HBr and chars. All the specimens, even those giving low analyses, when reduced by $SnCl_2$ in presence of alcohol, give tetrabromo-diphenol of considerable purity, melting between 255° and 262° C.

D. *Bis-tetrabromo-diphenoquinhydrone: action of caustic alkali on the quinone.*—If tetrabromo-diphenoquinone is moistened with a little alcohol and covered with excess of caustic alkali, it darkens, and in the course of a few hours is converted into a very beautiful dark blue substance, which is the alkali salt of the above quinhydrone. Heat assists the reaction, but leads to considerable destruction of the product. The product is very slightly soluble in water, and when washed out and air-dried possesses a bright copper lustre. The mother-liquor contains tetrabromo-diphenol and what appears to be tribromo-trihydroxy-diphenyl, and, in addition, about 8% of the original bromine as bromide. The blue compound gives a violet coloration to sulphuric acid. In the case of caustic soda, the yield of the blue substance is about 82% of the quinone used. Found Na = 4.2% in a specimen dried at 110°.

Further work was done with the same substance made directly from tetrabromo-diphenol dissolved in cold caustic soda, by addition of ammonium persulphate and thorough washing out on the Buchner-funnel until the substance began to dissolve. Dried at 120°, (when it lost its lustre, probably from conversion into the free quinhydrone and sodium carbonate by the CO_2 of the bath), it gave Na=4.00, C=27.10, H=0.97, Br=59.10, which agrees with ($C_{24}H_8Br_8O_4Na_2$ + H_2O + CO_2) or ($C_{24}H_{10}Br_8O_4$ + Na_2CO_3). The true formula for the undried substance is, therefore, $C_{24}H_8Br_8O_4Na_2$ (+Aq), being a combination of the quinone with the disodium-derivative of tetrabromo-diphenol in equal proportions. The free *quinhydrone* is obtained by acidifying the blue substance and washing out. Stable on drying, it forms minute greenish-brown needles, with bright-green metallic lustre, giving the violet coloration in sulphuric acid. Found $Br=62.35$ and 62.20, so that it is apparently hydrated. Theory for $C_{24}H_{10}Br_8O_4 + 2H_2O=61.65\%$ Br. The *potassium-derivative*, made from di-potassium tetrabromo-diphenol and potassium ferricyanide, is less soluble in water, and has less lustre (specimen dried at 80° in bath after extinguishing the light): found $K=7.00$ and $Br=56.55$ (averages). Theory for $C_{24}H_8Br_8O_4K_2 + 2H_2O$ is $K=6.90$ and $Br=56.70$.

E. *Action of strong hydrobromic acid on the quinone.*—On the analogy of the work on coerulignone, this was expected to give penta-bromo-diphenol (see Liebermann and others on 2—bromo-hydro-coerulignone). Experiment showed, however, that bromine was liberated freely, and the only organic product was tetrabromo-diphenol, reduction thus having occurred.

When the quinhydrone or its blue salts are warmed with acetic anhydride, it is split into tetrabromo-diphenol-diacetate and a red quinonoid body. This latter appears to be identical with tetrabromo-dipheno-quinone, but on analysis gives too low results for bromine: found 60.3, 60.45 and 60.34% Br instead of 64. A similar product is obtained by treating alkaline tetrabromo-diphenol with a large excess of alkaline oxidant, and then acidifying This specimen, after thorough percolation with alcohol and water, gave $Br=60.0$ and 59.2. The reduction-product melted at 238° only and seemed quite oxidizable. Prolonged boiling of tetrabromo-dipheno-quinone itself, with acetic anhydride, causes the whole to react, and the products are the above diacetate, and a more soluble substance melting at 190°, apparently tri-acetoxy-tribromodiphenol.

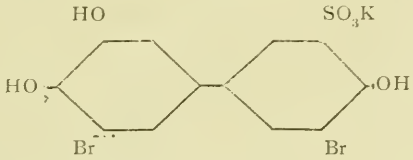
An attempt to make a mixed quinhydrone from diphenoquinone and tetrabromo-diphenol gave only diphenoquinhydrone.

F. *Reduction of tetrabromo-diphenoquinone.*—This was done quantitatively by moistening with alcohol, covering with normal stannous chloride (in HCl) in a weigh-bottle nearly filled with the mixture and digesting on water-bath until the solid was white: by back-titration with iodine, the amount of $SnCl_2$ used in the reduction was found to be 0.396% calculated as hydrogen. The theory is 0.400. The crude reduction-product was free from tin and melted at 260-264°, and was therefore pure tetrabromo-diphenol.

G. *Reduction of the quinone with bisulphite.*—This gives about 80% of the tetrabromo-diphenol, the rest having been converted into 3-3′-5- tribromo-diphenol-sulphonic acid, since from 6 to 8% of ionic bromine was found in the liquors. The above acid could not be isolated: on concentration in presence of the HNO_3 (from double decomposition with $AgNO_3$ to determine free bromide) it reacted, giving a yellow nitro-compound melting at 210°. The potassium salt of this, brick-red, sparingly soluble, gave on analysis K=14.4, Br=44.1. The same substance is apparently obtained by nitrating the crude tribromo-diphenol of page 323. Found in K-salt, K=15.0. Br=41.0. It is probably impure 3′ nitro-3-5-5-′ tribromo-diphenol. Owing to the low solubility of the starting material—tetrabromodiphenol—none of these substances can be conveniently prepared in quantity.

H. *Action of neutral sulphite on tetrabromodiphenoquinone.*—This is similar, except that nearly twice as much bromine is split off. From the mother-liquor, after removing tetrabromodiphenol, I isolated a quantity of potassium dibromo-diphenol-disulphonate (already described in *Trans. Chem. Soc., London, 1907, 1308*), giving a brilliant blue colouration with $FeCl_3$. Found K=12.53, S=11.50. Theory: K=13.4, S=11.1. On nitration this gives 3-3′ dinitro-5-5′ dibromo-diphenol of m.p. 237°. Another salt is present, much more soluble, and giving an olive colour with $FeCl_3$. This is probably the result of replacing part of the bromine in tetrabromo-diphenol by hydroxyl, so as to give an adjacent dihydroxy-derivative, which explains the colour.

Again, on using silver bisulphite for reduction, a similar substance, but containing the sulphonic group, was obtained. Its potassium salt also formed white needles, and gives the *olive* coloration with $FeCl_3$. Found K=8.6. Br=33.8



requires K=8.2, Br=33.5.

I. The substance described by the author in 1906 as "true tetrabromo-diphenoquinone" made by Willstaetter's method (PbO_2 in dry benzene), has never been obtained in sufficient quantity to investigate. The only analysis made gave 60.1% Br, which is nearly 4% too low for tetrabromo-diphenoquinone. The white product obtained by reducing it with $SnCl_2$ melted at 245-8°, and was mainly tetrabromo-diphenol. The original substance is probably tetrabromo-diphenoquinone, accompanied or combined with dibromo-quinone; and the name "true tetrabromo-diphenoquinone" should be withdrawn.

J. *Preparation of 2-6 dibromo-quinone.—2-6 dibromo-sulphanilic acid* was first made by treating solution of potassium sulphanilate with a mixture of bromate and bromide, and acidifying until some tribromaniline separates; the filtered liquor was neutralised with ammonia and concentrated. This gives a much better yield than the methods in the literature. The potassium salt forms rather sparingly soluble needles, and gives a blood-red coloration with $FeCl_3$. When dissolved in warm dilute sulphuric acid and treated with CrO_3 in excess, it is converted into the dibromo-quinone, which separates as a brown oil, rapidly solidifying: recrystallised from benzene with addition of alcohol, rejecting the insoluble part (which is sulphate of dibrom-aniline): the quinone forms deep golden needles melting at 130°, and with H_2SO_4 gives a bright reddish-orange coloration. 2-6-dibromo-quinol,* by $SnCl_2$, forms fine long silky needles, melting at 163°. *(Bis)-2-6-dibromo-quinhydrone* is pinkish violet, with dull purple lustre, giving a blue sodium-salt, and is easily resolved into its components. It gives the same coloration as the quinone with sulphuric acid.

Remarkable Lunar Halo.—The April issue of the *Quarterly Journal of the Royal Meteorological Society* has a short account of an unusual lunar halo observed from the R.M.S. *Balmoral Castle* last January. The halo was described as being square with quite straight sides and the angles quite sharp. The length of each side was estimated to be three lunar diameters. An entry of the phenomenon, accompanied by a sketch showing the halo with one of the angles directed towards the horizon, appears in the ship's log. The halo was first noticed shortly after 6 p.m. on the 21st, and was still visible at five o'clock on the following morning.

The Zodiacal Light.—At a meeting of the British Astronomical Association on the 2nd April, Mr. Gavin J. Burns, Director of the Zodiacal Light Section, said that he had been asked why it was that the zodiacal light was generally, or always, brighter on its northern edge. The reason that he suggested was that the northern edge, being the highest above the horizon, was less influenced by atmospheric absorption. Should this be the correct explanation, the southern edge should be the brighter in south latitudes. The hope was therefore expressed that observations would be made by persons residing in southern latitudes and the results communicated to him.

Hen Birds with Male Plumage.—In the *Union Agricultural Journal* for September, 1912 (Vol. iv, p. 381) there appeared a photograph of a hen ostrich (from the farm of Mr. W. Rubidge, Graaff-Reinet Division), seven years of age, whose ovaries had been removed at the age of three years, whereupon the bird had forthwith assumed the plumage of a cock. *Apropos* of this, the Director of the Melbourne Zoological Gardens writes in the May issue of *Knowledge* that, as is well known, disease or removal of the ovaries, in the case of hen pheasants, and probably also in poultry, brings about a similar change of plumage. He suggests that hen birds of all kinds would be affected in the same way under such circumstances. In the Melbourne Gardens, some years ago, an old male ostrich, apparently badly diseased, assumed the garb of a hen, and died shortly afterwards, but owing to the Director's absence the body was not preserved.

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* See also Ling, *J. Chem. Soc. London*, 1892, p. 562.

THE HISTORY OF SEKWATI.

By Rev. Johannes August Winter.

Introduction.

When the capital of old Tulare at Steelpoort had been destroyed by Mosilikatse, after an awful fight which lasted a whole day, and the deep donga was quite filled up with corpses,* the Zulus settled down at Steelpoort for some time. Sekwati went to the north of Zoutpansberg, and by killing out little kraals and capturing women and cattle, he afterwards became a great man. At that time Mosilikatse used to send *impis* there annually to collect taxes. Sekwati thereupon fled into the Woodbush, always coming out again after the Zulus had left. Later on he came to Magalie, where the Boers and the Zulus in vain tried to storm his stronghold, and whence, after these had gone home, Sekwati sent them peace-offerings. He must have been a genius. In his old age he became partially paralysed in his feet. He was kind to the first missionaries, whom he assisted in 1861 in his isolated stronghold, Thaba Mosigo, on the farm Hackney—where I still found the hut alongside his grave in the cattle kraal half-way up the hill, and where, at night, sacrifices and prayers are still offered. *Moroa-Sekwati* is still an honoured title.

Sekwati, flying from the Zulus, crossed the Olifants River with a considerable remnant of Tulare's men and women into Zoutpansberg, first to Mapahlele's Kraal, south of Pietersburg. He did not stay there long, but went to Botlokoa, to the north of Pietersburg. There he said to the Chief, "Tell me the names of all kraals which are inimical to you. I shall fight with them and so get food for the road." In this way he went first to Boroka in the Ba-Mafefera (near Haenertsburg). There he settled for some time, and commencing raids round about, he got large quantities of cattle. He gave part of this loot to Mamohlatlo, widow of Malekut, and to her young son Tulare, who was of the same age as Sekukuni. This woman, however, grumbled about the cattle, saying, "You do not give me enough." Sekwati, displeased at this, went back to Botlokoa. From there he went to Ganana (Blauwberg), where he found a white man (the first Boer), Kadisha, near the great Zoutpan. Sekwati drove the people of Ganana from the salt-pan and they commenced to fight him. Sekwati was victorious. Kadisha was a friend of Sekwati, and went with him on many of his raids. Kadisha had no gun, but fought with bows and arrows. He had no white wife, but several black ones—in fact he was then Paramount Native Chief there, notwithstanding his white colour. Then Sekwati crossed the Limpopo River and went to Bokalaota (a Bakgalaka tribe like Mapela, near Piet-Potgieters Rust) and took many cattle kraals away, the

* See this volume p. 98.

owners being afraid of fighting him. Kadisha, on this occasion, did not go with him. On his way back Mosilikatse's men took the cattle from him. Sekwati, avoiding a fight, fled. The other remnant of Tulare's Bapedi with Malekut's widow and son, also went from place to place to seek food and cattle. The Ba-Mapela and Ba-Mokopane, together with Magakal, attacked and killed them all. Sekwati now wished to go back to Sekukuni-land. He had no cattle, but many goats, taken from outlying kraals of the Bakgalakas. He passed Moletlane and came to the Olifants River opposite Magalie. The Olifants River was full. He cried across the river to Magalie's men to inform him when the river was down, as his camp was some distance from the river, at the hill Sepitsi. When he was there the Ba-Moletlane said to their Chief Zebediele, "Let us kill Sekwati." The Chief objected, saying, "Let him cross. He will assist us against the Mokoni-Marangrang, who always trouble us." As soon as the river was down he crossed and settled at Magalie's, who were friendly and welcomed him. At that time, under the Mokoni-Marangrang (whose head kraal was near Rietfontein, Dwars River), Legadimani of Magakal was the next powerful Chief here, and ruled as far as Magalies. Molamosu, father of Legadimane, when at his cattle-kraal at Waterkop, was murdered by Marangrang. When Legadimani greeted Sekwati, the latter called him a coward for not fighting Marangrang; and when Legadimani said, "He is too powerful," Sekwati answered that he would soon finish him. But before he did this there arose a quarrel between him and Legadimani, who was then at Mpanama's Location, and, afraid of being killed, fled across the Olifants River to Matabata (Molepo River). Shortly after, Marangrang—to whom Sekwati had sent some beads as a sign of friendship—which, however, did not deceive the latter with regard to Sekwati's real feelings—went with an *impi* to raid the Ba-Mapahlele. He went far round the other side of Pokwani. There he found that some men of Matlala had killed a giraffe, and he not only took this, but also killed the hunters, of whom one escaped. The Chief of Matlala (Kotola Maseramule) sent at once to Sekwati, saying, "Here is your Mokoni, but I do not know where he is going to." Marangrang crossed the river high up, came down the other side, and slept at the hill Sepitsi. Meanwhile Sekwati had sent to Mapahlela to say, "Be not afraid. The Mokoni comes. Kill him." The Ba-Mapahlela fought bravely in the flat and killed Marangrang. They took the shield of Marangrang, gave it to Magabutle, Sekwati's messenger, to show him that they had killed him. The man came late in the night, and at once during that same night Sekwati blew his war horns (phalafala—sable antelope horn) and sent messengers to all kraals with orders for the men to gather and go with him to destroy the capital of Marangrang. When he came there, however, he did not burn the kraal, but only looted a great many cattle and went home wtih the first cattle round about. Kabu, who had previously been with Marangrang, now crossed Steelpoort and settled at Magnet Heights. Many of Sekwati's people were tired of his rule, so they left and settled with Kabu. Sekwati at once took up arms and went to fight Kabu. Kabu and his men fled into the Lolu above Seopela (Schoonoord). Sekwati camped at Schoonoord, made many big fires to decive the enemy (as Frederick II. of Prussia once did), left early in the night, and marched all night through to Pa'hla (Mooifontein). Kabu next morning took this as a sign that Sekwati was afraid and followed him. Sekwati camped at a spruit, a little distance from Pa'hla's kraal. Kabu came before sunrise and attacked the Ba-Pa'hla while they were still asleep and suspected nothing. As soon as Sekwati heard the noise and shouts, he attacked the Ba-Kabu from behind and killed them, together with their auxiliaries, the old Makgema cannibals, many Bakonis and Mapulanas. He captured Kabu, but did not kill him. Kabu, however, fled away to Ohrigstad. While there he allied himself with Legadimani (Magakal), who gave Kabu a wife. Sekwati now asked Kabu to raid the Ba-Marabe (Marabastad, otherwise Pietersburg). They went. The Ba-Marabi not only drove them off, but killed them all. Both Kabu and Legadimani were amongst the slain. Then Sekwati went and looted all the cattle of Magakal.

After this there came an *impi* of the Swazis (under Somotobi, father of Umsutu, grandfather of Shopean), and attacked Sekwati, but they were driven off.

Then came a Zulu *impi*, sent by Panda, from Zululand. They were nearly successful in their attack, but could not manage the rocky hill (Phiring). After they left, Sekwati sent a messenger, Mangakane, with ostrich-feathers and skins of the tshipa (much prized by the Zulus) as peace offering. When this messenger arrived at Panda's, his mother mocked them because of the strange coverings round their loins. Panda thanked them and sent word: "That is all right now between us, but Sekwati must not sleep when the dogs bark. I am not the only enemy." He also sent some Zulus back with the messenger, to whom Sekwati gave some cattle as a gift to Panda. From there until lately the Bapedi from time to time sent tribute and so kept up the old good feeling between them.

Now came the first rumour about white men (the Boers).* Some Boers with Ntere'ke (Hendrik Potgieter), coming from Waterberg, called Sekwati to the drift at the Olifants River (at Molalegi's, Mathebe's). Sekwati went with all his men, with elephant tusks and some goats and sheep as a present. The Boers were glad to see him, and said, "Let us be friends." Then they passed over Magnet Heights to Ohrigstad, where they settled. They often came to hunt elephants together with Sekwati's men.

Afterwards Hendrik Potgieter begged a commando from

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* On first seeing white faces, the people said, "*Ki Tulare, o tsogile*": (It is Tulare; he has come up again). Because he also was very light in colour.

Sekwati to raid the Ba-Moletshi (Zoutpansberg). Sekwati personally went with him and a big *impi*. They killed Moletshi's men and took a very large number of cattle-herds, small stock, and also women and children. After the fight, when the Bapedi were killing and eating the captured goats and sheep, Kadisha told Potgieter: "You do not know these men of Sekwati. I know them. You had better turn round and kill them also at once." Potgieter agreed to this. He called Sekwati alone to his camp, and turned round with all his Boers to the mass of Sekwati's warriors, standing only fifty yards away, and fired at them. They fled. The Boers on horseback rode after them and brought them back again. When Sekwati complained, they answered: "We did this because you were killing so many goats. Although you have taken the goats you ought to have brought them to us." The Ba-Mpahlele, Ba-Nkoane, Ba-Mpanama suffered most by this onslaught. The Boers now took all the clothes (pieces of thin cloth, bought by the people from wandering Makoapa from Delagoa Bay) and skins, but left the arms and shields. Now Sekwati sent all the auxiliaries home, remaining only with his own men. Then the Boers said: "All the men of Sekwati must go home, but Sekwati must remain with us." So Sekwati sent them home with young Sekukuni, also with some cattle and goats which the Boers gave him. A few days later he went home, too. The Boers also went home. Later they left Ohrigstad and went to settle near Mokopane (Piet Potgieters Rust). From there they went together in a big commando of all native tribes (except Mapahlele) and came to attack Sekwati at Magalies. At first they were able to get up the hill of the stronghold to the top. But at the last strong enclosure the Bapedi drove them out and down again. The Bapedi also had guns from Moshoesh, Basutoland. The Boers surrounded the hill, keeping the Bapedi from the water. They had been joined by a second detachment of Boers from Lydenburg. One day they cried out, "The women may come and fetch water." But when these came the Boers shot some of them; others had succeeded in going back with water. The cattle on the hill had been dying from hunger and thirst. The people sucked the stomachs of these. One night Sekukuni, with the young men and girls, went down, drove in the Boer outposts and brought water up. After that the Boers no longer put their night outposts near the water, and so the Bapedis had enough water. A party of Boers then went round to Lolu as far as Magakal, across the Olifants River, and took many herds of cattle. As soon as these arrived the Boers left, one commando for Zoutpansberg, the other for Lydenburg.

After this Sekwati sent a peace-offering of elephant tusks to Hendrik Potgieter, but found that the latter had just died—all the women were wearing black.

Sekwati then left Magalies and went over the Lolu to settle on the Hill Mosigo, which was full of caves. There he was left undisturbed until he died in 1861.

AGRICULTURAL STATISTICS.

By G. F. Joubert.

In dealing with the subject of Agricultural Statistics—their nature, their collection, their compilation, and their value—I shall keep in view, as far as possible, South African demands. In the first place, the question arises: What are Agricultural Statistics? We must endeavour to arrive at a good definition: one not simply for an august body such as the South African Association for the Advancement of Science (for whom alone this Paper would be superfluous), but one that the farming community of the Union may understand, and so come to see the great value of the Agricultural Statistics for themselves.

What, then, are Agricultural Statistics? It is a mathematical science, and yet not an exact science like arithmetic. It is the science of averages; the science of great numbers. It is the collection, compilation, tabulation and publication of data relating to all or part of the Agricultural products and livestock of a country, or matters appertaining thereto: it is the keeping of records of the agricultural resources and requirements. It is Bookkeeping with the Statistician as bookkeeper—the study of the receipts, expenditure and savings of each individual, and therefore of the country collectively. It is a scientific study of supply and demand; of what the country produces and can produce. It reveals the defects and shows when the balance is on the wrong side of the ledger. I have not the slightest doubt that for us in South Africa it will reveal a vast field for expansion.

The next question will be: What is the value of Agricultural Statistics?

Agricultural Statistics, if collected and compiled at frequent intervals—say every year, if possible—form a record of the country's growth. Without them it is impossible to say what progress the country is making. Statistics of Exports give some idea of this, but, because they do not reflect the internal consumption of domestic products, and consequently do not permit the total production of the country to be arrived at, they are not sufficiently comprehensive to be of real value as a record of the country's growth.

Agricultural Statistics show us what the country produces, what the country possesses, what the country consumes, what the country requires; and, read in conjunction with the Customs Statistics, they show us in what we are deficient. In short, they must incite us to greater efforts.

Agricultural Statistics are of value inasmuch as they supply the Economist with the material for his investigations in the form of facts. Their value is brought out when they are studied comparatively, for they must run over several consecutive years in order to show the increase or decrease, the advance, the progress or otherwise, of a country's industries, and to give some idea as to its agricultural prospects. Compared with those of other countries, too, these Statistics will show us where there is room for improvement. The yield per acre, as ascertained by the Agricultural Statistics of this country, will reveal a surprisingly low average when compared with that of older countries. It will show the necessity for the use of fertilizers and for proper cultivation of the ground. It will direct our attention to other countries, when we shall see what they have accomplished, and perhaps inquire into their methods.

We produce, we buy, and we sell. In importing we buy; in exporting we sell. And when we turn our attention to the Customs Statistics, what do we find? That in Livestock and Agricultural Products we imported into the Union during last year commodities to the tune of £8,500,000; whilst we exported products to the value of £9,000,000. Agriculturally speaking, therefore, we sell very little more than we buy; and when we know that of the total value of exports about £5,000,000 is represented by wool and mohair, and £2,250,000 by ostrich feathers, the amount to be placed to the credit of agriculture proper is no more than the paltry sum of £1,500,000, which plainly shows that the tilling of the soil does not receive the attention which it might. This knowledge ought to instil in the bosom of every man, woman and child who lives in the country a desire to contribute his or her share towards getting this state of things altered; in other words, encourage local industries.

What a field for improvement presents itself to our mind's eye! Our great aim ought to be to bring the Producer, the Consumer and the Commercial man together or in closer relation to one another. The one is dependent on the other; their interests are the same.

In short, we cannot do without Agricultural Statistics. Commercial men continually apply to the Department of Agriculture for information. The Shipping Companies want to know what we are going to export in quantity; how many bags of maize, for instance, there will be for export, and so forth. We must be in a position to give the information, as our reputation—that is, the reputation of the Agricultural Department—is concerned.

The two great phases to be considered are, firstly, the Collection, and secondly, the Compilation and Tabulation of Agricultural Statistics. Time will not permit our going into the matter in detail and dealing with all the aspects of the case. We can only, therefore, confine ourselves to a broad outline and touch on the most important matters.

Collection.

Under this heading we have to consider (1) The System; (2) The Procedure (or how to collect); (3) The Enumerators, Agents and Correspondents; (4) Uniformity with other countries.

The System.

What system should we adopt? We must keep pace with other countries, and yet we must not lose sight of the fact that we are young and have our own conditions and peculiarities to consider. In other words, we shall have to turn our attention to older countries and base our system on their experience. But here caution is required, and the attempt must not be made to force the coat of the giant on to the shoulders of the young man. The system must be adapted to the requirements of South Africa.

There are the two systems, the Descriptive and the Numerical. The question arises, which of the two are we to adopt? In my humble opinion I think that an amalgamation of the two will meet our case. Our country is sparsely populated, and does not present any great difficulty in the collection of numerical data. It is the system which we have applied in the Transvaal, so far with success.

First, we should have estimates (which must be monthly) of the coming crops, and after the harvest the actual yield must be ascertained. The actual yield is a check on the estimates and supplies a basis for the Agents on which to work the following season.

For monthly or frequent and prompt forecasts the descriptive method must be applied.

There is an idea that the Census could be taken as a base on which to work. The Census is taken every five years. If this be done, then I feel convinced that at the end of each quinquennial period we shall always find ourselves wide of the mark; and such Statistics are misleading and do more harm than good.

I would certainly counsel that we begin in a small way, *i.e.*, with the principal products only, especially those that are being exported. Make a good job of it and thus win the confidence of the public and especially of the commercial world. As time rolls on and experience is gained we could gradually expand.

The machinery ought to be perfect and not beggarly; but for the first few years we can safely let alone such systems as Logarithmic curves or Algebraic treatment.

The mistakes of other countries ought to be an object lesson to us, and we must try to avoid falling into similar errors. If we turn our attention to the system in vogue in the United States of America, we find to our disappointment that it is not perfect, to say the least of it; and I say this, not with any idea of criticism, but as a warning. I will not presume to express an opinion but will let better men than myself speak.

If we turn our attention to the report of the proceedings of a meeting of the Royal Statistical Society, held on May 16th, 1911, we find the following opinions expressed :—

Mr. H. D. Vigor, B.Sc., said: Normal does not indicate a perfect crop. Normal comes between average and possible maximum. Full normal is the condition of perfect healthfulness, unimpaired by drought, hail, insects or other injurious agency, and with unimpaired growth and development. (In other words, the climatic conditions must be perfect.) Full normal is indicated by 100. If thirty bushels of corn be taken as the full normal yield, a condition of 90 would give a prospect of a crop of 27 bushels, and 80 a crop of 24. Full normal, *i.e.*, 100, does not indicate a perfect or the largest possible crop; it may be exceeded.

Mr. C. P. Sanger thought it might be said with some truth that the official figures of the United States, and those given in *The Times*, relating to Normal Crops did not mean anything; that is to say, in order to attach any meaning to them, they had to be expressed in percentages of other figures. It would be very interesting to find the reason why those who were responsible for the collection of statistics should adopt methods which produced statistics very difficult to interpret, if indeed they could be interpreted.

Mr. Kains-Jackson said they had been told that during the last ten years or more the word "normal" had been used by statistical bodies, but these bodies had found that it was not a very good description so that some now used the phrase "ideal" in place of "normal." That word in turn was open to great objection, although it was better understood than "normal." What he would venture to suggest, as a desirable course for a statistical body, was not to dispense with these normal figures in favour of average figures, but to have two sets of figures instead of only the normal; the second to be an average based on the total number of years that statistical returns have been taken, the average being also taken for a comparatively short period, such as ten years.

In the *Corn Trade News* of July 11th, 1911, under the heading "Weekly Review of the Grain Trade," we read:

The following statement shows in a tabular form the statistical history of the last American crop with comparisons:—

Season reckoned 1st July to 30th June.

	Bushels.
Farmers' reserves 1st July, 1910	39,000,000
Merchants	35,000,000
New crop harvested	695,000,000
Total available	769,000,000
Distribution—	
	Bushels.
Twelve months' exports	70,000,000
Quantity seeded	80,000,000
Quantity consumed or hidden away in invisible channels	533,000,000
Now in farmers' hands (official estimate)	38,000,000
Grand visible supply now	48,000,000
Total accounted for	769,000,000

In the above, we have assumed the absolute correctness of the American official estimates, which we admit is assuming a good deal.

The indication from the foregoing figures is that the *per capita* consumption in the United States last season amounted to five and two-thirds bushels in addition to the quantity used for seed. This rate is equal to an increase of about a bushel per head over the generally accepted rate of former years. Such a large increase is more than enough to place a big tax upon our faith in the general accuracy of these American statistics. As the *Corn Trade News* has shown before, it was formerly a difficulty to discover whence the big exportable surpluses of those seasons come from; now the boot is on the other leg. A dozen years ago the phenomena were only to be explained by supposing that the *per capita* consumption had fallen below four and two-thirds bushels; now that the exportable surpluses are not forthcoming as expected, it is claimed that the domestic consumption has increased a bushel per head over the normal. As before stated in these columns, we hesitate to accept the explanation. Our own belief is, that the American crop is now regularly overestimated by the Washington officials. It seems little short of ridiculous to suppose that each man, woman and child is now eating 120 lbs. of bread more per annum than was the case a dozen years ago.

I merely quote the foregoing to show that the descriptive system alone does not give satisfaction, and must inevitably lead to disappointment.

"Full normal," *i.e.*, 100, is the term used as a base from which to work. But such terms as "normal," "full normal," "average," "ideal," etc., however cleverly manipulated do not give the actual and correct returns. We are obliged to take off our coats and set to work in order to get what we want, that is, reliable returns which will not mislead us, but which will show us our actual condition and where we stand.

The Procedure (or How to Collect).

The procedure in connection with the collection of the required data is a difficulty which we agricultural statisticians have to face. By far the greater majority of farmers keep no records of what they sow or reap, in the first place; and in the second place, they have no scales to weigh their produce, but simply fill the bags. Again the farmer has his enemies and is robbed of part of his crop by bipeds, quadrupeds and millipeds. Neither is he himself very particular. A few handfuls will go to the poultry to keep them off; a few cobs of maize to the pigs to stop their noise, etc. So that to get absolutely correct returns is out of the question. This is also not what we look for. We have already stated that statistics is the science of averages—the science of great numbers.

In the collection of data, or the material wanted, blank forms must be issued. In the drafting of these forms great care must be exercised. The simpler they are, the less chance is there for mistakes. The questions ought to be put in as simple language as possible, so that anybody can understand them; and they should not involve the necessity of giving descriptive answers. A simple number or the word "Yes" or "No" must be the answer given. Queries ought not to be ambiguous or equivocal; there must be no loophole of escape. They ought also to be so worded as not to give offence or create suspicion.

The public must have the positive assurance that all information given is strictly confidential, and will on no account be divulged by the statistician to anybody of whatever standing. For that purpose the statistician ought to be supplied with a proper safe, or safe receptacle for the safe-keeping of all forms and papers. In the Transvaal we have already been approached for information relative to the assets of individuals, which information we have courteously, but most emphatically, refused.

When a country begins collecting and compiling agricultural statistics, the first year's figures can only be taken as approximately correct. As years go on and the work progresses, and the foundations on which to work become more and more settled, the figures also approximate nearer and nearer to accuracy. Work for accuracy with the individuals and the sum total will be right. It may seem illogical, but it is a fact, that individual members of a whole group may vary considerably, whereas the whole group varies very slowly. There may be a difference in yield on one farm or another or even in one district or another. A farm may produce considerably less than the previous year, but then there will be another farm that will make up for it in producing considerably more, and thus there will not be much difference in the total.

Another thing that must also be borne in mind is, that the people have to be educated up to the fact that the periodical collection of agricultural statistics is necessary. When we started in the Transvaal—this was in October, 1908—we had the farmers against us. They were prejudiced against the idea and had the most wonderful notions about it. I visited the different wards and held meetings with the object of convincing the prejudiced. When explaining to them the objects of the collection of agricultural statistics I put the matter to them in this way: "What do you think of a farmer who is unable to tell you how many head of cattle he possesses, or sheep, or other stock, or how many bags of grain he has reaped?" The reply invariably was, that such a man was not worthy the name of farmer. To which I would add, "Yes, and suppose any of you were to meet General Botha and say to him, 'General, you are Minister of Agriculture. Can you tell me how many head of cattle and sheep, etc., you have in the country, or how many bags of mealies the country produces?' and he said, 'I don't know.'" This was generally convincing. With such and other arguments I found no difficulty in persuading them of the value and desirability of reliable statistics.

The proper season for the collection of agricultural statistics differs. Over the greater part of South Africa the months of June, July and August would be the best. For tropical fruits, tea and sugar, perhaps another season will have to be selected.

The winter months offer themselves as the best, being the dead season of the year, when the harvests are in and the ploughing more or less finished.

The attempts made so far in the four Provinces to collect agricultural statistics can at best only be called spasmodic. I think we all agree that the time has arrived when an honest attempt should be made to collect, compile, tabulate and publish reliable statistics for South Africa.

Enumerators, Agents and Correspondents.

In the Transvaal, so far, we have had the field-cornets to assist us in the collection of actual data, and with them correspondents to assist with the estimates. The native commissioners, and also the police, have contributed their share towards the work. The question now to be dealt with is, who are to be the enumerators?

The Provinces differ, and the past systems of Government differed; but now a uniform system of Government is being introduced. We already stand under one Agricultural Department.

We have the magistrates, who could supervise as far as their magisterial divisions are concerned. The stock inspectors, the police, schoolmasters, native commissioners, and missionaries among the natives, are all mentioned as capable men who might assist. But then how about remuneration? It is admitted that the work ought to be done with as little expense as possible.

To appoint men who will neglect their work will never do. I think that we ought not to confine ourselves to one single class, but make use of whatever good material we can lay our hands on. For instance, the stock inspectors may be good men in one or another province, and the police again in another; whereas the native commissioners may be the right men for the natives.

The question, therefore, as to who are to be the enumerators is not easily settled. Unfortunately, mankind is beset with evils, and that is just where the difficulty lies, to get so many hundreds of enumerators, agents and correspondents who will honestly and conscientiously and in a capable manner collect and supply the required data. It is not essential that the enumerators should be university men precisely; a knowledge of elementary arithmetic is sufficient. Honesty of purpose is the great essential. Agents and correspondents ought to be men who are practical farmers, or who have a practical knowledge of farming. It is marvellous to see how some of the farmers, although practically uneducated, yet taught by long experience, can estimate correctly the yield of a crop when still on the lands. I know by experience that the great, and I make bold to say the only, drawback is the collection, the acquiring of the figures and information wanted. Once we have that, the rest is smooth sailing.

Once a lady was troubled with certain insects which the old Roman called "Cimices." She could not get rid of them. A tramp heard of this and thought there was a chance to earn, let us say, an honest penny without the sweat of his brow. He approached the lady and told her that he knew of a remedy and would tell her, provided she gave him five shillings, which she did. "Ma'am," he said, "you catch the bug and knock his brains out with a hammer." He did not wait to listen to the parliamentary language that followed.

That is just where our trouble lies; it is to catch them.

Uniformity the World Over.

I believe in the saying, "The earth is my fatherland and to do good is my religion." If in any way possible, steps ought to be taken to have a uniform system all over the world—a system which can be applied everywhere and *suited* to local conditions; of the same pattern although not of the same size. Perhaps the time is nearly ripe when we also, like Canada, may adopt the decimal system. This in itself will be a step towards uniformity.

The King of Italy has taken the initiative, and let us hope that the day is not far distant when we shall be in possession not only of agricultural, but of all statistics.

The second phase is

The Compilation.

In discussing the procedure, or how to collect, I have already touched on the scientific aspect and secrecy. It is therefore not necessary to say much more on those points.

There are two main forms in which statistical information could be published:—

(1) The publication at frequent intervals, say monthly, if possible, of the estimates or forecasts of the principal crops. These forecasts might be published in the *Government Gazette* and the *Agricultural Journal*, and might also be supplied to the Press.

(2) Annual handbooks of statistics containing the record for the past year, and comprising sufficient data to enable any man of average intelligence to follow the progress or otherwise of the country in any given line of agricultural activity. This means that in the compilation, tabulation and publication of our statistics we must bear in mind that our work must be explicit, and in simple form, and easy of interpretation. As already quoted, Mr. Sanger at the Royal Statistical Society's meeting, expressed the opinion that it would be very interesting to know the reason why those who were responsible for the collection of statistics should adopt methods which produced statistics very difficult to interpret, if indeed they could be interpreted. By all means we must avoid such criticism. What is the good of statistics which are unintelligible? Statistics are not meant for ornament or a means to supply certain men with a living! They can be of the greatest possible use. They are a necessity. They are material with which to build. They are the thermometer which shows the rise and fall

of a country's activity and vitality. The matter is a serious one, and we cannot afford to trifle with it. The idea that a good statistician can sit in his office, and, by conjuring with and manipulating figures, can give reliable forecasts and yields of crops, is idiotic, to say the least of it. And yet there are people who have that idea.

There was once a man, with a scientific and statistical mind, who maintained that by taking the dimensions of a cow and by taking x as the unknown quantity of milk, one could by a simple algebraical equation calculate what the yield of milk would be after the cow had calved. I am afraid that it will take some time yet before science shall have reached such a wonderful stage of evolution. For the present we are compelled to apply ourselves to present-day realities.

Legislation.

Proper and reliable statistics are most essential in connection with the carrying on and the development of the farming industry. Considering the great value attaching to these figures—a value which is becoming more apparent as time goes on—we feel the great necessity of proper legislation in order to facilitate matters—legislation compelling everybody to give correct information of the nature required. This is especially the case with the Natives.

As far as secrecy is concerned legislation would prove a safeguard to the public.

The Statistician.

The last, but not least, is the statistician. As a statistician I do not wish to express my own opinion of what a statistician is or ought to be; I will let another, more capable than myself, speak. Mr. Arthur L. Bowley, M.A., F.S.S., says:—

> The statistician furnishes the political economist with the facts, by which he tests his theories or on which he bases them. Since the economist deals chiefly with phenomena relating to groups, and regards the individual only as a member of a group; it is to statistics as the science of averages that he looks for his information. When he is dealing with national economy with the volume of trade, for instance, or the purchasing power of money, he is limited to pure theory, till the statistician has provided the facts. The chemist experimenting in his laboratory is like the statistician: the chemist theorising in his study is like the economist. Because of this relation it may be held to be the business of the statistician to collect, arrange, and describe, like a careful experimentist, but to draw no deductions; even in an investigation relating to cause and effect, to present evidence, but no conclusions.

The statistician investigates and gives evidence, but is not the judge to draw conclusions. He ought to be not only an educated man, but at the same time must know the country and local conditions, the people and the manners and customs. He is the controller of the work executed by the men under him, and for that reason these qualifications are essential.

When I started holding meetings among the farmers in the Transvaal, the field-cornets were notified that the statistician would visit their wards for that purpose, and to give him all the assistance possible. Arriving at a certain field-cornet's house, I introduced myself, saying that I was the statistician; whereupon he said, "Well, I never! I could not make out what sort of a thing the statistician was, and did not like to betray my ignorance by asking." Jokingly, he said he thought it was a kind of pig without hair.

One man in all seriousness asked his field-cornet whether it was something new that was imported into the country. The field-cornet asked him to explain himself, when he said, "Well, something that is imported in tins!"

Yet another was under the impression that it was some new bacteriological creature discovered by Dr. Theiler.

They were all surprised that it was a man who could address them in their own language on a subject quite new to them, but whom, after explanations, they hailed with delight.

In conclusion, I trust that my endeavour, however weak, may bear fruit in suggesting some new idea, and that it may be of some guidance in the future as regards statistics in this country. I venture to say that the matter is of such importance that there is no necessity for excuse in bringing it forward. Every little time devoted to this is given to a good cause.

Ozone in Natural Waters.—The *Chemiker Zeitung* records the occurrence of ozone in springs near Monte Arniata (Italy), whose radio-activity was being investigated. A phosphorus-like odour of the water has now been traced to ozone. The water contains ferrous carbonate, which in oxidation, probably produced hydrogen peroxide, and it is presumed that this, in the presence of organic substances, gives rise to ozone.

ADDITIONS AND CORRECTIONS TO THE RECORDED FLORA OF THE TRANSVAAL AND SWAZILAND.

(*July 1st*, 1911, *to June 30th*, 1912.)

By Joseph Burtt-Davy, F.L.S., F.R.G.S.

In a country like South Africa, which is still to so great an extent new ground from the scientific point of view, and where so much "spade work" has yet to be done before we can generalise to any extent, it is desirable that workers should be kept in touch with the work done from year to year in those branches in which they are interested.

This is of importance not only to the professional, but also to the lay worker, who often lacks other facilities for keeping informed of the progress being made. To the student of systematic and geographical botany it would be of great assistance could he find gathered together in one place a list of the species new to the phyto-geographical region in which he is particularly interested, together with notes of extension of recorded distribution, and ecological notes on species already known to occur. In my own work I have greatly felt the need for some such list, and have had to fall back on my own efforts to prepare it. As far as I have them, the records up to the present year have been brought together in the form of a Check-list, and to this Mrs. Pott-Leendertz has added the additional records contained in the Transvaal Museum Herbarium. This list was published in the *Annals of the Transvaal Museum*, Vol. iii, No. 3.

Since then a few omissions have been discovered, and several additional species have been found in working over material collected. As far as these are known they have been embodied in the following notes, which include several important additions to the flora of extra-tropical South Africa.

The twenty-nine species marked with an asterisk are additions to the Check-list, bringing the total up to 3,298 species and 923 genera.

In the following notes I have departed from the phyto-geographical terminology of the *Flora Capensis*, which includes most of the Transvaal in its "Kalahari Region." I have for a long time realised that it includes parts of several quite distinct regions. For present purposes it is sufficient to indicate them broadly as follows:—

1. The Grass-steppe Region of the Transvaal Highveld, which extends into the Eastern Orange Free State and includes the Uplands of Natal.

2. The Limpopo Basin Region of the Transvaal Bushveld, which extends northward towards the Zambesi and north-westward through the Bechuanaland Protectorate, and includes the Lebombo Flats in Swaziland.

3. The Southern Bechuanaland Region, which includes the

South-Western Transvaal, North-Western Orange Free State, British Bechuanaland and Griqualand West.

4. The Mist-belt Region of the Drakensberg.

It is to the combination of these four very distinct phyto-geographical regions that we owe the wealth of genera and species here included in our Check-list, and to which we must still expect a vast number of additions.

Bibliography Cited.

1911.—Schinz, Prof. Dr. Hans (Zurich): "Beitrage zur Kentniss der Afrikanischen Flora" (xxiv) in *Vierteljahrschrift der Zürich Naturf. Gesellschaft*, Jahrgang 56, Heft iii, pp. 229-268, December 23rd, 1911. New species: *Hermbstædtia capitata* Schinz (p. 233); *Brassica pachypoda* Thell (p. 257). New names: *Roripa nudiuscula* (E. Meyer?) Thell. (p. 259). syn. *Arabis* (?) *nudiuscula* E. Mey.; *Roripa nudiuscula*, forma *integrifolia* (Szysz.) Thell. (p. 260), syn. *Nasturtium indicum*. var. *integrifolia* Szysz; *Roripa nudiuscula*, forma *pinnatifida* Thell. (p. 260).

New locality records for: *Hermbstædtia transvaalensis* Lopr., *Hermbstædtia rubromarginata* C. H. Wright, *Sericorema remotiflora* (Hook.) Lopr.

1911.—"Diagnoses Africanæ," xxxix. in *Kew Bulletin*, 1911, No. 2. New species: *Protea transvaalensis* Phillips, p. 84. The remaining numbers of the series in this volume contain no new Transvaal species.

1911.—Burtt-Davy, J., and Appleton, Lieut.-Col. A. F., "Economic Notes on the Transvaal Grasses," in *Kew Bulletin*, 1911, No. 3, pp. 158-161 (April 20th, 1911).

New combinations: *Cymbopogon marginatus* Stapf., var. *validus* Stapf., Syn. *Andropogon nardus* L., var. *validus* Stapf.; *Cymbopogon polyneuros* Stapf., *Syn. Andropogon Schœnanthus* L., var. *versicolor* Steud.

1911.—Rendle, Baker, Moore, Gepp and Swynnerton, "A Contribution to our Knowledge of the Flora of Gazaland," in *Journ. Linn. Soc.*, Vol. xl., No. 275 (September 21st, 1911). The following are noted as occurring also in the Transvaal*: *Viola abyssinica* Hochst.; *Polygala hottentotta* Presl.; *Securidaca longipedunculata*, var. *parvifolia* Oliv.; *Hypericum lanceolatum* Lam.; *Grewia occidentalis* Linn.; *Triumfetta pilosa* Roth.; *Ximenia americana* Linn.; *Rhus tomentosa* Linn.; *Rhus Sonderi* Engl.; *Scleroscarpa caffra* Sond.; *Lotononis aristata* Schinz.; *Indigofera hilaris* E. and Z.; *I. hedyantha* E. and Z.; *Vigna hirta* Hook.; *Dolichos brachypus* Harms.; *Rhynchosia clivorum* S. Moore; *Rhynchosia monophylla* Schltr.; *Flemingia rhodocarpa* Baker; *Bolusanthus speciosus* Harms.; *Bauhinia Galpini* N. E. Br.; *Acacia horrida*

* Doubtless from herbarium material in the Natural History Museum; some of these are new "records" for the Transvaal.

Willd.; *Combretum erythrophyllum* Sond.; *C. apiculatum* Sond.; *C. suluense* Engl. and Diels.; *C. Zeyheri* Sond.; *C. porphyrolepis* Engl. and Diels.; *Cephalanthus natalensis* Oliver; *Adina microcephala* Hiern; *Canthium mundtianum* Ch. and Schl.; *Fadogia Cienkowskii* Schweinf.; *Vernonia Bainesii* Oliv. and Hiern.; *Melanthera Brownei* Sch. Bip. ("Northern South Africa"); *Chironia transvaalensis* Gilg. ("Northern South Africa"); *Swertia stellarioides* Ficalho; *Solanum indicum* Linn.; *Hebenstreitia elongata* Bolus; *Lippia Wilmsii* H. H. W. Pears.; *Bouchea Wilmsii* Guerke; *Clerodendron myricoides* R. Br.; *Aristolochia Petersiana* Klotzsch; *Faurea speciosa* Welw.; *Acalypha villicaulis* Hochst.; *Aristea compressa* Buching; *Gloriosa superba* Linn.; *Pycreus rehmannianus* C. B. Cl.; *Cyperus albostriatus* Schrad.; *Ischæmum glaucostachyum* Stapf.; *Cymbopogon Schoenanthus* Spreng., var. *versicolor* Hack.; *C. rufus* Rendle; *C. Ruprechtii* Rendle; *Panicum trichopus* Hochst. *Sporobolus festivus* Hochst.f.

In addition to the above, a considerable proportion of the plants enumerated is also met with in the Transvaal.

1911.—Chandler, B., M.A., B.Sc., "On *Utricularia prehensilis*, E. Mey.," in *Notes from the Botanic Garden*, Edinburgh, No. xxii, pp. 39-42, Plate LVII (October, 1911).

1912 (March), *Kew Bulletin* No. 2 ("Diagnoses Africanæ," xlvi), pp. 90-107. New Species: *Bridelia mollis* Hutch., p. 100.

1912.—Wood, J. Medley, A.L.S., "Natal Plants," vol. vi, part iv (1912), contains no new records, but the following Transvaal species are illustrated:—

Clivia Gardeni Hook., Plate 578; *Fleurya capensis* Wedd. Plate 577; *Aloe Marlothii* A. Berg., Plates 579 and 580; *Mackaya bella* Harv., Plate 585; *Brachystelma Barberiæ* Harv., Plate 587; *Helichrysum calocephalum* Klatt., Plate 589; *Rhamnus Zeyheri* Sond., Plate 590; *Portulaca caffra* Thunb. (*Talinum caffrum* E. and Z.), Plate 593 ("The plant . . . has lately been moved to the genus *Portulaca*"); *Thunbergia atriplicifolia* E. Mey., Plate 594 ("Natal Primrose"); *Buphane disticha* Herb., Plate 595; *Solanum panduræforme* E. Mey., Plate 596; *Ilysanthes nana* Engl., Plate 597; *Orthosiphon Wilmsii* Guerke, Plate 598; *Asclepias cultriformis* (Harv.) Schltr., Plate 599; *Adenium swazicum* Stapf., Plate 600.

1912 (June 6th).—Burtt-Davy, J., and Pott-Leendertz, R., "A First Check-list of the Flowering Plants and Ferns of the Transvaal and Swaziland," reprint from *Annals of the Transvaal Museum*, vol. iii, No. 3, May, 1912. The following new combinations appear for the first time (as far as the authors are aware):—

Adenia digitata (Harv.) Harms. = *Modecca digitata* Harv.
Adenia gummifera (Harv.) Harms. = *Modecca gummifera* Harv.

Adenia hastata (Harv.) Harms. = *Modecca hastata* Harv.

Anemone canescens (Szysz.) Prantl. = *Knowltonia canescens* Szysz.

Anemone transvaalensis (Szysz) Prantl. = *Knowltonia transvaalensis* Szysz.

Anemone Knowltonia Burtt-Davy = *Knowltonia gracilis* DC., not *Anemone gracilis Fr. Schmidt.*

Barbacenia humilis (Baker) Pax. = *Vellozia humilis* Baker.

Barbacenia retinervis (Baker) Pax. = *Vellozia retinervis* Baker.

Barbacenia rosea (Baker) Pax. = *Vellozia rosea* Baker.

Barbacenia Schlechteri (Baker) Pax. = *Vellozia Schlechteri* Baker.

Barbacenia villosa (Baker) Pax = *Vellozia villosa* Baker.

Barbacenia violacea (Baker) Pax. = *Vellozia violacea* Baker.

Barbacenia viscosa (Baker) Pax. = *Vellozia viscosa* Baker.

Berkheya echinacea (Harv.) O. Hoffm. = *Stobæa echinacea* Harv.

Berkheya onopordifolia (DC.) O. Hoffm. = *Stoæa onopordifolia* DC.

Berkheya Radula (Harv.) O. Hoffm. = *Stobæa Radula* Harv.

Berkheya speciosa (DC.) O. Hoffm. = *Stobæa speciosa* DC..

Bonamia capensis (Baker) Peter = *Breweria capensis* Baker.

Bonamia capensis, var. *oligotricha* (Baker) Peter = *Breweria capensis,* var. *oligotricha* Baker.

Bonamia suffruticosa (Schinz) Peter = *Breweria suffruticosa* Schinz.

Bonamia suffruticosa, var. *hirsutissima* (Hall. f.) Peter = *Breweria suffruticosa,* var. *hirsutissima* Hall. *f.*

Choritænia capensis (Sond. and Harv.) Benth. and Hook. = *Pappea capensis* Sond. and Harv. (1862), not of Ecklon and Zeyher.

Cissus cirrhosa Willd., var. *transvaalensis* (Szysz.) Gilg. = *Vitis cirrhosa,* var. *transvaalensis* Szysz.

Cissus humilis (N. E. Br.) Gilg. = *Vitis humilis* N. E. Br.

Cissus succulenta (Galpin) Gilg. = *Vitis succulenta* Galpin.

Coccinia natalensis (Oliv.) Cogn. = *Cephalandra natalensis* Oliv.

Cymbopogon hirtus (Linn.) Stapf. = *Andropogon hirtus* Linn.

Cymbopogon marginatus (Steud.) Stapf. = *Andropogon Nardus* Linn, var. *marginatus* Steud.

Cymbopogon validus Stapf. = *Andropogon Nardus* Linn., var. *validus* Stapf.

Cymbopogon pleiarthron Stapf. = *Andropogon pleiarthron* Stapf.

Cymbopogon plurinodis Stapf. = *Andropogon plurinodis* Stapf.

Cymbopogon excavatus (Hochst.) Stapf. = *Andropogon Schœnanthus* Linn., var. *versicolor* Steud.

Cymbopogon transvaalensis Stapf. = *Andropogon transvaalensis* Stapf.

Epaltes scabra (Harv.) O. Hoffm. = *Litogyne scabra* Harv.

Felicia asper (DC.) O.Hoffm. = *Diplopappus asper* DC.
Felicia filifolia (DC.) O. Hoffm. = *Diplopappus filifolius* DC.
Felicia serrulata (Harv.) O. Hoffm., var. *xylophylla* (Klatt.) O. Hoffm. = *Aster xylophyllus* Klatt.
Ficus Pretoriæ Burtt-Davy = *F. salicifolia* Vahl., var. *australis* Warb.
Heeria salicina (Sond.) Engl. = *Rhus salicina* Sond.
Hermannia coccocarpa (E. and Z.) K. Schum. = *Mahernia coccocarpa* E. and Z.
Hermannia multicaulis, var. *latifolia* (Harv.) K. Schum = *Mahernia erodioides* Burch., var. *latifolia* Harv.
Hermannia vestita (Harv.) K. Schum. = *Mahernia vestita* Harv.
Hoffmanseggia Sandersoni (Harv.) Benth and Hook = *Melanosticta Sandersoni* Harv.
Inula lanceolata (Harv.) O. Hoffm. = *Pegolettia lanceolata* Harv.
Ormocarpum trichocarpum (Taub.) Harms. = *Diphaca trichocarpa* Taub.
Pachystigma Cienkowskii (Schweinf.) K. Schum. = *Fadogia Cienkowskii* Schwein.
Pituranthos Burchellii (Sond.) Benth. and Hook. = *Deverra Burchellii* Sond.
Plectronia transvaalensis (S. Moore) K. Schum. = *Canthium transvaalensis* S. Moore.
Rhoicissus erythrodes (Fres.) Planch., var. *ferruginea* (Baker) Gilg=*Vitis erythrodes*, var. *ferruginea* Baker.
Rhoicissus rhomboidea (E. Mey.) Planch., var. *transvaalensis* (Szysz.) Gilg=*Vitis rhomboidea*, var. *transvaalensis* Szysz.
Sorghum halepense Nees, var. *effusum* (Stapf.) Burtt-Davy = *Andropogon halepensis*, var. *effusus* Stapf.
Sorghum vulgare Pers., var. *Schenkii* (Körn.) Burtt-Davy = *Andropogon Sorghum* Brot., var. *Schenkii* Körn.
Syzygium Gerrardi (Harv.) Hochst. = *Acmena Gerrardi* Harv.
Tragia cordata (Harv.) Pax. = *Ctenomeria cordata* Harv.
Tricalysia lanceolata (Sond.) K. Schum.=*Kraussia lanceolata* Sond.
Tricalysia pavettoides (Harv.) K. Schum = *Kraussia pavettoides* Harv.

1912.—Gilg and Brandt, in Engler's *Botanischen Jahrbücher*, 46 Band, Heft 3 und 4. New species: *Cissus Wilmsii* Gilg and Brandt; *C. spinosopilosa* Gilg and Brandt; *C. Woodii* Gilg and Brandt. New records: *Rhoicissus capensis* (Burm.) Planch.; *Cissus gracilis* Guill. and Pers. New names: *Rhoicissus cirrhifolia* (Linn. f.) Gilg and Brandt, syn. *R. cuneifolia* (E. and Z.) Planch.; *R. digitata* (Linn. f.) Gilg and Brandt, syn. *R. Thunbergii* (E. and Z.) Planch.

I am indebted to the Rev. F. A. Rogers for calling my attention to these omissions from the Check-list, due to the fact that the latter was practically completed in November, but was delayed until May owing to my constant absence from Pretoria.

1912.—Thiselton-Dyer, Sir W. T., "Flora of Tropical Africa," Vol. vi, sec. 1, Part 4 (issued 1912). Records *Bridelia cathartica* Bertol, and *B. mollis* Hutch., as occurring in the Transvaal.

Amphidoxa gnaphalioides DC., "Prodr.," vi, 246; *Flora Capensis*, iii, 263; No. 3,022 of the Check-list (Compositæ).—This pretty little plant has the aspect of a *Gnaphalium* or of *Helichrysum declinatum*, as pointed out by Harvey. From *Helichrysum* it differs in the absence of pappus to the numerous marginal female flowers. I have collected it in the following localities:—

Bloemhof Dist.: Kaffraria, Christiana, March 8th, 1912, wet ground and on islets in shallow dam, associated with *Panicum Holubii*; Burtt-Davy, 12801.

Mafeking Div.: Setlagoli Native Reserve, November 13th, 1911, Burtt-Davy, 11040.

Vryburg Div.: Mimiesfontein (H. Hobson's), November 15th, 1911, Burtt-Davy, 11097.

Boshoff Dist.: Smitskraal, near Christiana, in brak soil along the Vaal River, September 21st, 1911, Burtt-Davy, 10855.

Its occurrence in the Southern Bechuanaland Region is an interesting extension of known range, as the *Flora Capensis* records it only from the vicinity of Uitenhage and Port Elizabeth.

*(Andropogon pertusus Willd., var. capensis Hack. (?) Andropogon. In "DC. Monogr. Phan.," vi, 479; *Flora Capensis*, vii, 345. (Gramineæ).—Included in Burtt-Davy and Appleton, *loc. cit.* The specimen was not seen by Dr. Stapf. As there is no mention of the locality from which Lieut.-Col. Appleton obtained the specimen, and as it is known that his collections included some grasses from other parts of South Africa, this cannot be taken as a definite record, and must be queried until actual Transvaal material is obtained, especially as the range of the species appears to be restricted to the "Coast" and "Eastern" Regions of the *Flora Capensis*.

Androstachys Johnsonii Prain, in *Kew Bulletin*, 1908, p. 439!; Thiselton-Dyer, "Flora of Tropical Africa," vi, sect. 1, part iii (1912); *Weihea* (?) *subpeltata* Sim, "Foreign Flora of Portuguese East Africa," p. 66, t. lxi (1909) (Euphorbiaceæ).—Mr. Sim had neither flowers nor fruit, and was unable to do more than guess at the family and genus. Through the courtesy of Mr. Warner, Resident Magistrate at Stegi, on the Lebombo Mountains, fruiting material was recently obtained, which suggested the family Euphorbiaceæ, though the fruits were sometimes 4-locular. Looking through the description in the recently-issued part of the "Flora of Tropical Africa," that of *Androstachys Johnsonii* seemed to fit my specimens; material was submitted to Kew for comparison with the type, and the tentative determination confirmed.

Androstachys subpeltata is a small tree with straight stem and very hard wood, which is said to be termite-proof; the soundness and apparent age of logs and stumps of trees lying in the forest suggest that this opinion may be correct. The tree is gregarious, forming almost pure thickets in kloofs and along the ephemeral streams which course down the eastern face of the Lebombo range of mountains, chiefly on the Portuguese side of the border. My own specimens were collected on the road to Mailiana railway station, and just at the foot of the mountain. I have already included it (under *Weihea*) in the list of Transvaal and Swaziland plants, on the strength of information that it occurs on the Swaziland side of the border, in kloofs where the larger rivers cut through the mountain range on their way to the sea. But it is not characteristic of the *western face* of the Lebombo, if it occurs there at all, which I doubt. The occurrence of this tree so far south is interesting, though not surprising.

It is known to the Swazis as "ubu-koomkoo," and is valued for its hard, straight wood. A resident of Swaziland has acquired a concession to cut the timber over many miles of Portuguese territory, and proposes to send the poles and smaller pieces to the Transvaal for fencing material, for which it appears to be admirably suited.

Mr. Sim states that he was informed separately by English, Dutch, Kaffirs and Swazis on the Lebombo that bees nesting in this tree make poisonous honey. I have heard that honey made from the nectar of the common tree Euphorbia of the Waterberg District is also poisonous.

He further notes that specimens were sent from Mozambique in connection with an enquiry as to its suitability for railway sleepers. Mr. Sim "saw no outwardly damaged trees," though he saw all ages, "fine, clean, straight stems in every case; but I was informed that the very large trees are usually hollow. . . . Bark grey, fissured both ways, red under the cortex, thin."

*Antirrhinum Orontium Linn, var. grandiflorum Chav. (Scrophulariaceæ).—Native of South Europe and Asia Minor, naturalised in fields of grain and forage at the Government Experiment Farm, Potchefstroom, and the Government Stud Farm, Standerton, as early as 1908.

*Barleria Irritans Nees (Acanthaceæ).—Cawood's Hope, near Christiana, March, 1912, Burtt-Davy, 12930. This plant was plentiful on an isolated patch a few acres in extent not far from the Vaal River, which produced a peculiar plant-society quite different from that of the rest of the region. This plant-society included a species of *Mesembrianthemum*; two species of *Eragrostis* (one of which, *E. bergiana* Trin, is also new to the Transvaal), and *Dimorphotheca Zeyheri*, in addition to some species generally met with in the region, such as *Gazania longifolia* and *Ipomœa angustisecta*. *Barleria irritans* does not appear to have been frequently collected, but it has a wide distribution, from the vicinity of Uitenhage in the Coast Region, through the Central Region (Somerset, Graaff-Reinet and Calvinia Divisions) to Great Namaqualand in the Western Region, and the Southern Bechuanaland Region (Griqualand West, Hay and Bloemhof Districts). Its altitudinal range is from 1,000 feet near Uitenhage to 4,000 feet at Groot Boetsap.

*ASTRAGALUS BURKEANUS Benth. (Leguminosæ).—Magaliesberg, Burke and Zeyher (*teste* Harv. in *Flora Capensis*). I can only conclude that this was accidentally omitted in writing out the MSS. from the card catalogue.

*BRASSICA PACHYPODA Thellung, *loc. cit.* (Cruciferæ).—Type locality: Sudafrika, pr. Phœnix, *Schlechter,* 3146. Distribution: Transvaalkolonie, Pretoria, 1904, R. Leendertz, 416 (sub *Sinapis retrorsa*), *teste* Thellung. Also in Basutoland.

*BRIDELIA CATHARTICA, Bertol, f. Illustr. Mozambiq. 16, n. 13, t. 6 (Euphorbiaceæ); Hutchinson in "Flora of Tropical Africa," vi, sec. 1, part 4, p. 617 (1912). Distribution: Mozambique District; "occurs also in the Transvaal" (Hutchinson *loc. cit.*).

BRIDELIA MOLLIS Hutchinson in *Kew Bulletin* (1912), No. 2, p. 100 (March, 1912), and in Thiselton-Dyer, "Flora of Tropical Africa," *loc. cit.*, p. 612 (1912); *B. stipularis* Muell. Arg., in "DC. Prodr.," xv, part ii, p. 499 partly (as to Kirk's and Burke's Magaliesberg specimens), not of Blume; this is No. 1611 *B. stipularis* Blume, of the Check-list. Hutchinson cites the following specimens:—

Magaliesberg range, *Burke*; Streydpoort, *Rehmann,* 5393; near Rustenberg, *Pegler,* 1063; Warmbaths, Waterberg, *Burtt-Davy,* 5603. This is distinctly a sub-tropical Bush-veld (Upper Limpopo Basin) species, and extends north (according to Hutchinson) to the Zambesi (Boruma and Tete).

CISSUS CACTIFORMIS Gilg (Vitaceæ).—Syn. *Cissus succulenta* (Galpin) Gilg., in Burtt-Davy and Pott-Leendertz, *loc. cit.,* p. 121; *Vitis succulenta* Galpin, *teste* Gilg and Brandt, *loc. cit.*

CISSUS CONNIVENS Lamk. (Vitaceæ).—Syn. *Cissus orientalis* Harv. (*non* Lamk?); *Vitis natalitia* Szysz.

*CISSUS GRACILIS Guill and Perr. (Vitaceæ).—Syn., *C. bigemina* Harv., *C. tenuicaulis* Hook., *Vitis gracilis* Baker.

*CISSUS PAUCIDENTATA Klotzsch (Vitaceæ).—Syn. *C. cirrhosa*, var. *glabra* Szysz. Transvaal, *teste* Gilg and Brandt, *loc. cit.*

CISSUS SANDERSONII Harv. (*non* Planch.) (Vitaceæ).—Syn. *Vitis cirrhosa* var. *transvaalensis* Szysz.

*CISSUS SPINOSOPILOSA Gilg and Brandt, *loc. cit.* (Vitaceæ); Transvaal *teste* Gilg and Brandt, *loc. cit.*

*COMBRETUM IMBERBE Wawra., var. PETERSII (Klotzsch) Engl. and Diels, "Monogr. Afr. Pflanz.," iii., 14 (1899) (Combretaceæ).—*Argyrodendron Petersii* Klotzsch in Peters' "Mossamb.," p. 101 (1862); *Combretum Petersii* (Klotzsch) Engl., in "Pflanzenveld Ost-Afrikas," C. 290, *pro parte*; *C. Petersii* (Klotzsch) Engl., var. *Dielsii* Engl. and Diels, *loc. cit.*; *C. truncatum* Welw., *ex* Lawson in Oliv., "Flora of Tropical Africa," ii, 427 (1871).

Engler and Diels (*loc. cit.*) refer here to the *C. elæagnoides* of "Flora of Tropical Africa," but the style of the latter is described as non-glandular, while in ours the glands are very prominent.

Vernacular names: Lead-wood, Lood-hout, Mozambiti (Mozambique Region, *teste* Kirk); Munangare (in Sena, *teste* Peters); Ironwood, Yzerhout, M'ponda-indhlovu or im-Pondo-in-Dhlovu (Swazi, *i.e.*, "elephant tusks"), true Harde-kuil (*teste* Legat); Mookarire (Modjajes).

Barberton, 1,000 feet: a small tree, flowers yellow, December 12th, 1903, *T. C. Legge* 41 (herb., 1749); Barberton District, November, 1905, *P. Oranje* (herb., 1344); near Barberton, August, 1904, *Legat* (herb., 929); between Louws Creek and the Adamanda Mine, Barberton District, July 8th, 1906, *Burtt-Davy*, 2819. Swaziland: between Buckham's and Forbes's Coal Mine, June 22nd, 1911, *Burtt-Davy*, 10682. Zoutpansberg District: Koodoos River, August 22nd, 1905; *Grenfell* (herb., 1018); between Thabina and Sutherland's, *circa* 2,500 feet alt., called "Mookarire," June 14th, 1906, *Burtt-Davy*, 2917. Pretoria District: Bush-veld along the Crocodile River, Roodekopjes 44, *Burtt-Davy*; Kleinfontein No. 7, March 22nd, 1907, *L. Reck* (herb., 184); Bush-veld near the junction of the Pienaar's and Aapjes Rivers, 1905, *L. Reck* (herb., 1082 and 1083); Potgietersrust, Waterberg District, June 17th, 1908, *Legat* (herb., 4556); and April 13th, 1906, *Burtt-Davy*, 2250.

Wood described as "black and red" (*Grenfell*); "exactly like that of the lignum-vitæ" ("Flora of Tropical Africa"): "extremely heavy and termite proof" (*D. Forbes*); "liefert gutes Nutzholz" (*Peters*).

An exceptionally large tree for the part of the country where it grows; trunk and main branches white (hence the Swazi name). The stipitate glands of the style appear to be peculiar to this species, as far as known; if they occur also in *C. primigenum* of Marloth and Engler, the latter would appear to be only a geographical variety of *C. imberbe*. The fact that *C. imberbe* is variable, and that one variety occurs in the vicinity of rivers in the dry Bush-veld of sub-tropical and tropical Transvaal, gives colour to the suggestion that the species might range in one or other form west to Damaraland and the northern Kalahari. Extends north to the Zambesi and west to Angola.

Combretum porphyrolepis Engl. and Diels, "Monogr. Afr. Pfl.," iii, 63 (1899).—Shrub or small tree with divaricate branches. Eastern Bush-veld of the Transvaal and Swaziland: Barberton District: Queen's River Valley, Barberton, 2,300 feet, flowers September, 1889, fruit January, 1890, Galpin, 560, 561, 756; Kaap Valley, near Barberton, 2,100-2,900 feet, flowering

September, 1890, *Galpin*, 756 (2); Komatiepoort, *circa* 975 feet, fruit December, 1897, *Schlechter*, 11772. Waterberg district: Makapansberg, near Streydpoort, *Rehmann* 5470. Swaziland: between Stogoti and the Black Mbelusi River, June 20th, 1911, *Burtt-Davy*, 10630.

I was mistaken in assigning the name of Leadwood to this species in my list of Native Trees of the Transvaal (1907); the geographical distribution in the Transvaal of *C. porphyrolepis* and *C. imberbe*, var. *Petersii*, appear to be the same.

(*COMBRETUM PRIMIGENUM, Marloth and Engl.?) (Combretaceæ). (See note under *C. imberbe*, above.)

*CONVOLVULUS ORNATUS Engl. (Convolvulaceæ).—Kaffraria, Christiana, March, 1912, *Burtt-Davy*, 12747. A characteristic plant of the Southern Bechuanaland phyto-geographical region, of which the Bloemhof District forms a part, but this is an easterly extension of its range, as it had not been previously recorded from the Transvaal. The previous records are for Bechuanaland, the Orange Free State, Griqualand West, and the Carnarvon Division, the first three localities being in the Kalahari Region, and the last in the Central Region, of the *Flora Capensis*.

*CUCUMIS FIGAREI Del. (Cucurbitaceæ).—Tzaneen, eastern Zoutpansberg District, *circa* 2,700 feet, alt., *I.B.Pole Evans* in Dep. of Agri. Herb, 3973, and in herb. Bolus. A tropical African species, also found in Natal.

CYMBOPOGON EXCAVATUS (Hochst.) Stapf, in Burtt-Davy and Pott-Leendertz, *loc. cit.*, *C. polyneuros* Stapf, in Burtt-Davy and Appleton, *loc. cit.*

CYMBOPOGON VALIDUS Stapf, in Burtt-Davy and Pott-Leendertz *loc. cit.*, syn., *C. Marginatus* Stapf, var. *validus* Stapf, in Burtt-Davy and Appleton, *loc. cit.*

*DIBCADI SPIRALE Baker (Liliaceæ).—Christiana Townlands, February, 1912, *Burtt-Davy*, 12495, plentiful; *fide* Miss Kensit; also collected at Kaffraria, near Christiana (rare) *Burtt-Davy*, and at Smitskraal, Boshof District, *Burtt-Davy*. Previously known only from the Hantam Mountains in the Calvinia Division, where the type was collected by Meyer; there were no specimens in the Kew Herbarium at the time of the publication of vol. vi of the *Flora Capensis*.

*ERAGROSTIS BERGIANA Trin (Gramineæ) (*fide* Miss Kensit).—Cawood's Hope, near Christiana, a few plants only, in a small island of peculiar vegetation in the heart of typical Bloemhof District vegetation, *Burtt-Davy*. A typical Karroo-veld species.

ERAGROSTIS BRIZOIDES Nees (Gramineæ).—The note under this name in Burtt-Davy and Appleton, *loc. cit.*, refers to *E. superba* Peyr; under some conditions of growth, the one is apt to resemble the other superficially.

*ERIOSPERMUM CORYMBOSUM Baker (Liliaceæ).—Townlands of Christiana, February, 1912, *Burtt-Davy*, 12493. Common;

fide Miss Kensit. Collected also at Kaffraria, Christiana, and at Smitskraal in the Boshof District. The solitary cordate-ovate leaf, which lies flat on the ground, is a characteristic feature of the flora where the grass tufts are scattered. As far as can be gathered from the *Flora Capensis,* this species is confined to the Southern Bechuanaland Region, having been collected only from Dutoit's Pan, Griqualand West (*Tuck, MacOwan*), and the Batlapin Territory of Bechuanaland (Holub).

*FARO SALUTARIS Welw. (Gentianaceæ).—Swaziland, *teste* Rogers in litt. A Tropical African species.

*GAZANIA LONGIFOLIA Less. (Compositæ).—Cawood's Hope, Christiana, March, 1912, Burtt-Davy, 12935; *fide* Miss Kensit. This species is plentiful in sand-veld on the south side of the Vaal River, at Smitskraal in the Boshof District, but seems to be less abundant on the north slopes, perhaps because the soil is usually harder and less sandy. The leaves of the Cawood's Hope plant are broader than in the Smitskraal form.

*HELICHRYSUM DREGEANUM Sond. and Harv. (Compositæ).—Kaffraria, Christiana, March, 1912, Burtt-Davy, 12749; *fide* Miss Kensit. The *Flora Capensis* records this species from the Stormberg, 5,000 to 6,000 feet, and the Witteberg, Albert Division.

*HERMANNIA BIPINNATA Linn.; *Mahernia bipinnata* Linn. (Sterculiaceæ).—Kaffraria, Christiana, March, 1912. *Burtt-Davy; fide* Miss Kensit. Also found at Smitskraal, Boshof District, and in Bechuanaland.

*HERMANNIA COMOSA Burch. (Sterculiaceæ).—Kaffraria, Christiana, March, 1912, *Burtt-Davy* 12494; *fide* Miss Kensit. Common and characteristic. The type was collected by *Burchell* in "South Africa"; no other records are given in the *Flora Capensis*; Harvey does not appear to have seen the plant, for, he writes, "Unknown to me," and quotes his description from De Candolle's "Prodromus."

*HERMBSTÆDTIA CAPITATA Schinz, *loc. cit.* (Amarantaceæ).—Type locality: Transvaal-Kolonie, in arenosis pr. Sandfontein, 1430 m., *Schlechter,* 4239, bl. u. fr., 19. 1. 1894.

KŒLERIA CAPENSIS Nees. In Linnæa, vii, 321 (Gramineæ).—In Burtt-Davy and Appleton, *loc. cit.*, Dr. Stapf has adopted this name in place of *Kœleria cristata* (Linn.) Pers. of the *Flora Capensis.* I have not access to sufficient literature to work up the synonymy of this species.

MARISCUS ALBOMARGINATUS, var. BINUCIFER C. B. Cl. (Cyperaceæ).—Kaffraria, Christiana, March 14th, 1912. *Burtt-Davy*, 13079, occurring in open grass veld, sporadically and not at all gregarious, but not uncommon in dry soils. The typical form occurs in the Uitenhage Division and in Griqualand West; the variety appears to have been recorded previously only from Pondoland (4,500 feet) (*Flora Capensis*).

*NESTLERA CONFERTA DC. (Compositæ).—Near Christiana, March, 1912, *Burtt-Davy*, 13079; also at Abramskraal 175, Boshof District, September 21st, 1911, *Burtt-Davy*, 10818; more abundant further south in the Orange Free State; apparently one of the characteristic species of certain soils in parts of the Composite-Karroo Region. Burchell collected it in very dry, stony places, between the Zak and Gariep Rivers, and Drège found it "on the Karroo and the Sneeuwberg" (*Flora Capensis*). An allied species (*N. humilis* Less) occurs near Uitenhage and Graaff-Reinet, which differs in its larger size and villoso-tomentose or woolly leaves.

OLDENLANDIA STRICTA (Smith) K. Schum. (Rubiaceæ).—Kaffraria, Christiana, March, 1912, *Burtt-Davy*, 12478 and 12819; *fide* Miss Kensit. Plentiful; the flowers open in the evening, and are then fragrant and conspicuous, white within, yellow without, but are inconspicuous when closed during the day. The *Flora Capensis* records this speices from the Winterveld and Nieuweveld, Thaba 'Nchu, Gamariver, Springbok-Keel and Namaqualand.

PANICUM MINUS Stapf, var. PLANIFOLIUM Stapf.—The note in Burtt-Davy and Appleton, *loc. cit.*, does not refer to this species, but to *P. lævifolium*, which was the grass originally submitted to me by Colonel Appleton. *Panicum minus*, var. *planifolium*, also occurs in the Transvaal, and apparently a specimen of this grass was sent to Kew with my note on *Panicum lævifolium* attached.

(PELARGONIUM BOWKERI Harv., *Flora Capensis*, ii, 592, 1862).—In "Natal Plants," *loc. cit.*, Mr. Medley Wood cites the locality of Bowker's collection as the "Transvaal"; this is clearly a typographical error for the Transkei (*vide Flora Capensis, loc. cit.*) We have no record of the occurrence of this species in the Transvaal.

*PHARNACEUM GRACILE Fenzl. (Aizoaceæ).—Kaffraria, Christiana, March, 1912, *Burtt-Davy*, 12777; *fide* Miss Kensit. Common in sandy soil where the grass-tufts are scattered or the veld generally thin. Collected by Drège "on the Great Karroo 2,000 to 3,000 feet" (*Flora Capensis*).

*RHOICISSUS CAPENSIS (Burm.). Planch. (Vitaceæ).—Transvaal, *teste* Gilg and Brandt.

RHOICISSUS CIRRHIFOLIA (Linn. f) Gilg and Brandt, *loc cit.* Syn., *R. cuneifolia* (E. and Z.) Planch.

RHOICISSUS DIGITATA (Linn. f) Gilg and Brandt, *loc. cit.* Syn., *R. Thunbergii* (E. and Z.) Planch.

RHYNCHOSIA NERVOSA Benth. (Leguminosæ).—Kaffraria, Christiana, March, 1912, a common and characteristic species; Burtt-Davy. Also at Smitskraal, Boshof District, *Burtt-Davy*, 12902.

RORIBA NUDIUSCULA (E. Meyr?) Thellung, *loc. cit.*, p. 259. Syn., *Arabis? nudiuscula* E. Mey., *ex* Harv. and Sond., *Flora Capensis* (Cruciferæ).

**Forma* 1, *pinnatifida Thell., loc. cit.*, p. 260. Type locality: in the Cape Colony, foot of the Boschberg. Transvaal:

in saxosis inter Waterval Rivier et Zuikerbosch Rand, 4600, 1893, *R. Schlechter*, No. 3483, *teste* Thellung.

Forma 2, integrifolia (Szysz.) Thell., *loc. cit.*, p. 260; Syn., *Nasturtium indicum*, var. *integrifolia* Szysz., "Polyp. Rehm.," 1 (1887), 13, p. 105. Type locality: Pretoria, Aapies Poort, *A. Rehmann* Exs. Afr. Austr. 1875-80, No. 4234, in herb. Zürich; Shilovane, *H. A. Junod*, 1334, *teste* Thellung, *loc. cit.*

*Salsola fœtida Del. (Chenopodiaceæ). — Kaffraria, Christiana, March, 1912, in brak soil, gregarious, forming a colony, *Burtt-Davy*, 12800; *fide* Miss Kensit. A "Ganna-bosch." Our plants were but a few inches high instead of "1 to 4 feet," and lacked the fœtid, fishy smell described by Dr. Bolus. This appears to be a rare plant in South Africa, or rarely collected, the only specimen cited in the *Flora Capensis* being *Bolus* 596 from Graaff-Reinet. Outside of South Africa it is found in Tropical and North Africa, Western Asia, and India.

*Sebæa macrantha Gilg. (Gentianaceæ).—Lydenburg District, Spitz-Kop, *Wilms*, 970, *teste* Hill in *Flora Capensis*, iv, p. 1083. Accidentally omitted from the Check-list.

*Senecio brachypodus DC, var. Discoideus Auct. Swaziland: *Burtt-Davy*, 10660; *fide* Miss Kensit.

Sisymbrium exasperatum Sond. (Cruciferæ).—Kaffraria, Christiana; plentiful in the shelter of low bushes, such as *Acacia stolonifera*, March, 1912. *Burtt-Davy*, 12471; *fide* Miss Kensit.

*Sutera aspalathoides (Benth) Hiern. (Scrophulariaceæ).—Kaffraria, Christiana, March, 1912, *Burtt-Davy*, 12955; *fide* Miss Kensit. In our plant the flowers are by no means "lilac or deep purple," but decidedly brownish yellow. The species appears to be common in the "Coast Region," but to have been only once recorded from the "Kalahari Region," *viz.*, by *Zeyher*, who collected it at Nieuwejaars Spruit, between the Orange and Caledon Rivers, altitude 4,000 to 5,000 feet (*vide Flora Capensis*).

Syzygium owariense (P. Beauv.) Benth.,"Fl. Nigrit.," 359; Syn., *Eugenia owariensis* P. Béauv.; Lawson in "Flora of Tropical Africa," ii, 438; *Jambosa owariensis* DC., "Prodr." iii, 287; *Syzygium guineense* Guill. and Pers., "Fl. Seneg.," i, 315, t. 72, *teste* Lawson, *loc. cit.; Syzygium sp. nov.* Burtt-Davy and Pott-Leendertz,, *loc. cit.*, No. 1,594. Native name in the Northern Zoutpansberg "Mphatatyatyi" (*teste Legat*).—White River Settlement, Barberton District, *Burtt-Davy;* between Thabina and Sutherland's, Ze, June 14th, 1906, *Burtt-Davy*, 2919; between Tzaneen and Medingen Mission station, Ze., June 16th, 1906, *Burtt-Davy*, 2647; Anton Villa, Ze., July 22nd, 1908, *Legat* (herb., 5223); Singerton, near Hector-Spruit, Barberton District, 1,300 feet, August 18th, 1908, *Burtt-Davy*; Swaziland, ridge overlooking Komatie Valley, grove of fine umbrageous trees, June 21st, 1911, *Burtt-Davy*, 10663. A tropical African species.

Also in Rhodesia: Southern Rhodesia, September, 1905, *Burtt-Davy*, 5303 (a form with a very sparse, open inflorescence and narrow, rather acuminate leaves); Zambesi 1903, *Chas. A. White* (herb., 2834); Victoria Falls, "Rain Forest," September 3rd, 1905, *Burtt-Davy*, 1369.

Since the above was written my attention has been called to Mons. Barbey's paper, "Sertum Plantarum Junodiarum," in *Bull. de l'Herb. Boiss*, 2me Ser., tome vi, No. 10, pp. 797-800, 1906, which had been overlooked. This paper includes the following eleven names not in the Check-list:—

Crassula Bolusi Hook. f.
C. pentandra Sch.
C. wilmsiana Diel.
Asclepias albens Schltr.
A. orbicularis Schltr. (*i.e.*, *Xysmalobium orbiculare* D. Dietr. of *Flora Capensis*).
A. physocarpa (E. Mey.) Schltr.
Periglossum mossambicense Schltr.
Sebæa barbeyana Schinz.
Aloe natalensis Wood.
Drimiopsis Woodii Baker.
Selaginella caffrorum (Milde) Hieron.

I have not included the species from Thaba Bossieu, which is in Basutoland. It is unfortunate that there is nothing in Mons. Barbey's paper to prevent the ordinary reader from concluding that this locality is in the Transvaal.

In the same publication the following additional Transvaal species and varieties are included in Professor Schinz's "Beiträge zur Kentniss der Afrikanischen-Flora, xix:—

Exochaenium grande (Steud) *Griseb*, var. *major* (S. Moore) Schinz; *Parasia grandis* (Steud.) Hiern., var. *major* S. Moore.

Plectranthus charianthus Briq., sp. nov.

Trochomeria macrocarpa Hook., var. *longipetala* Cogn., var. nov.

Mrs. Pott-Leendertz adds the following additional genera:—

Eleocharis limosa Schultes (Cyperaceæ).—Moorddrift, Waterberg District. I have seen a species of *Eleocharis* on the slopes of the Mauchsberg in the Lydenburg District.

Teramnus labialis Spreng. (Leguminosæ) Pretoria.

Agricultural Institutions in the United States.—The April issue (Vol. xxviii, No. 5) of the *Experiment Station Record* (U.S. Department of Agriculture) has an editorial on the co-ordination of State Agricultural Institutions. It is pointed out by the writer that hitherto relatively little attention has been given to the question of the best organisation of the agricultural work of a State as a whole, or to the relations which the various branches of the State's agricultural agencies should sustain toward each other. The tendency has therefore been for each agency to push its claims independently, and to endeavour to increase its importance by broadening the scope of its work at every opportunity. As long as the field was thinly covered and the aggregate of funds employed was small, this tendency attracted little attention. Growth, therefore, went on sporadically, and the competition of institutions was on the whole regarded merely as an indication of their healthy activity. Now, however, administrative officers, legislators, and the general public are awakening to the fact that the country's agricultural institutions are not organised on any consistent plan, and that they exhibit much heterogeneity of functions and actual overlapping of work. Competition among them has become insistent and disagreeable, and their demands complex and embarrassing. Naturally, says the writer of the article, the first outcry against the existing order of things is that there is waste of public funds through duplication of work. One of the remedies proposed is to bring all the agricultural agencies of the State under a single control, and to make the dominating feature of this control the business or financial management of the institutions, regardless of their character and purposes. As those agricultural institutions have up to the present been developed without any thorough study of their appropriate functions, there is said to be a bewildering variety in the organisation and work of institutions of the same general type in different States, and when any changes or transfers are suggested each institution is apt to defend its present status. As a result, the minds of legislators and the public become confused, and they are unable to determine whether there are really any fundamental principles by which their opinions and action may be safely guided. The distinctive business of an agricultural experiment station, it is pointed out, is research, and to this its functions should be restricted, though that should involve separation from the agricultural college. The hope is expressed that strong State Departments of Agriculture may be established, whose organisation and work will be distinctly differentiated from those of the colleges and stations, and which will take over from the latter the inspection and administrative work which had grown up in them because there had been no other place for it. The article closes with an animadversion on the building up of heterogeneous institutions where research is incidental and the investigator a business man, or has his time largely spent in teaching, travelling on inspection tours and testifying in the courts.

TRANSACTIONS OF SOCIETIES.

South African Institute of Electrical Engineers.—Thursday, March 27th: Mr. J. W. Kirkland, President, in the chair.—"Motor converters: their general characteristics and application in practice": J. W. **Saaler.** The author described and discussed the design of 3-phase and 2-phase converters, and made special reference to the practical working of converters under the heads of synchronising force, voltage regulation, commutation, three wire supply, reversibility, and efficiency.

Thursday, April 17th: Mr. J. W. Kirkland, President, in the chair.—"Mechanical defects in polyphase motors": W. C. **Brown.** The principal defects referred to were: vibration, resulting from the design of the slide rails or from the machines being top-heavy; troubles with pulleys, either resulting from their materials, or from their being keyed on to the shafts; the loss of time and expense owing to the more powerful motors not being supplied with split end shields and bearings; the difficulties consequent upon wear when motor-spindles have the same diameter throughout; and the insufficient provision of oil rings on bearings.

Royal Society of South Africa.—Wednesday, May 21st: Dr. L. Peringuey, D.Sc, F.E.S., F.Z.S., President, in the chair.—"Notes on Ngamiland": A. G. **Stigand.** A general account of Ngamiland and its inhabitants.—"Some new South African mosses": Prof. H. A. **Wager.** —"Magnetic observations taken at Bloemfontein": W. A. D. **Rudge.** An account of the diurnal range of declination at Bloemfontein from August to December, 1912. The mean value of the declination is about 24° W. The total change in declination has been as much as 10.8 minutes in a day. The change in position of the maximum, and also of the range, is of the same order as noted by General Sabine in the records taken at Cape Town more than sixty years ago.—"Notes on the vertebral column of the Bushman race in South Africa": Prof. R. B. **Thomson.** The bodies of the cervical and thoracic vertebræ are relatively narrower in their anterior-posterior diameter, and deeper in their vertical depth by about 5 per cent. as compared with Europeans.

Cape Chemical Society.—Friday, May 30th: Prof. R. Marloth, M.A., Ph.D., President, in the chair.—"The present state of knowledge of South African plants and plant products" (Presidential address): Prof R. **Marloth.** An account of chemical work done in connection with South African indigenous plants, arranged in botanical order. Special reference was made to plants and parts of plants used for tanning, to fodder plants and to medicinal and poisonous plants.

NEW BOOKS.

Gibson, J. Y.—*The story of the Zulus*: New ed. 9in. × 6in. pp. vii., 358 illus. London: Longmans, Green & Co., 1911. 10s. 6d.

Rolin, Henri. —*Les lois et l'administration de la Rhodésie.* 8vo. pp. xlvii, 532. Maps. Brussels: Emile Bruylant, 1913. 48oz., *fr.*15.

Brown, A. S. and **G. G.**—*The Guide to South and East Africa.* 12mo., pp. liv, 695. London: Sampson Low, Marston & Co., 1913. 24oz., 1s.

Hänsch, F.—*Die Aufteilung Afrikas.* pp. 27. Leipzig: B. G. Teubner, 1912. 3oz.

THE STUDY OF FRENCH IN FOREIGN UNIVERSITIES.

By Prof. RENICUS D. NAUTA.

The mission which higher education has to fulfil in the world of schools is incontestably a brilliant and an ideal one. In entrusting higher education with her most sacred interests, science gives herself up unreservedly, without diffidence, in all her purity and her entire fullness, with all her boldest moves and all her ambitions. Science bids higher education follow her unhesitatingly and untiringly in her interminable explorations and most strenuous research, and imposes on it, as its primary duty, to cause her to be respected by all, beloved by many and sedulously served by the happy few: the select, though constantly increasing, group of her faithful devotees and adepts. On the other hand, higher education, as an institution, is knit up with ancient traditions, inveterate customs, stiff-necked prejudices. Being part of the public service, it is dependent upon the freaks of politics and the economic necessities of the Budget. Not infrequently, the most generous-minded Minister must content himself with loving it with a purely platonic love.* It is a well-known fact that, with regard to the study of modern languages and their philology, higher education in Europe was very long in realising the urgency of drawing its Cinderella† within the circle of its motherly cares; and not less slow in extending to her the benefit of that "brilliant and ideal mission," it had been fulfilling so faithfully and for such a long series of years on behalf of the elder sisters, the classical languages. Consequently, the study and teaching of modern philology are comparatively young, and this is especially true for the philology of French and the history of mediæval French literature. Even in the universities of France itself, these higher studies are of comparatively recent date. It sounds almost incredible, but some eighty years ago France was still fairly indifferent with regard to the origin of its glorious language and the transformations which it had gone through in the course of time; and as for literature, students, who took an interest in what Boileau had rather superciliously and quite improperly styled: "*l'art confus de nos vieux romanciers*", were very scarce indeed. Besides, in those days, Germany had not yet opened up this new field of scientific research, on which its linguists have since brought to bear their efforts with that strenuous industry, that strict and rigorous method, which are among their least contestable virtues. However, if we wish to be historically correct, we ought to state that as far back as the sixteenth century France had indeed produced some few investigators, anxious to know the remote past of their country and their literature, rummagers of regests, muniments, and manuscripts. Claude

* Dr. A. G. van Hamel.

† Dr. B. Symons, Holland's greatest Germanist, in his lectures on Jacob Grimm.

Fauchet* and Etienne Pasquier†. Prominent between these two stands the admirable Charles Ducange, the author of the bulky *Glossarium mediae et infimae Latinitatis*, a work that has been world-famous ever since its publication.

Nor should we forget that the Benedictines, the only erudites of the Middle Ages, had then been working away for a considerable time at their monumental "*Histoire littéraire de France*," a work the continuation of which was taken in hand as recently as a little over eighty years ago, by the "Académie des Inscriptions et Belles-Lettres." Likewise it deserves mention that towards the end of the eighteenth century, one Barbazan, and after him Meon, Jubinal and others published fragments of ancient texts, selected preferably from popular literature; and that in 1808 the once famous grammarian, Roquefort, personally approached Napoleon I. with his "*Lexique roman*," of which both title and contents amazed the Emperor to a considerable extent. However, these works went by unnoticed and, neither in the world of letters nor in the University, did they meet with a responsive echo. It is quite probable that the absurd traditions, according to which French was said to be the offspring of Celtic, of Greek, of German, nay, even of Hebrew, were at that time no longer credited in France; but it is a fact that no objection was raised against spreading abroad an *obiter dictum* of Scaliger, in which this great philologist had confidently asserted that the French, Italian, and Spanish languages were merely "*des avortons du latin*." And even as late as 1854, Littré, the author of the famous "*Dictionnaire*," actually wrote down: "*chez nous beaucoup savent le latin, quelques-uns le grec, très peu le vieux français*." ‡

This strange indifference in French scholars with regard to the past of their language and literature may find a plausible explanation, first, in the constantly revived influence, which the classical renascence has never ceased to exercise in France on both letters and studies; and, secondly, in the naturally profound and all but exclusive veneration in which the masterworks of the seventeenth century have ever been held. Further, the great revolution, which, preaching overthrow and renewal in all things, was sadly unfit to carry the popular mind back to the literary glory of the Middle Ages, comes in for its share, as finally does the authority of the brilliant scholars, who represented and con-

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* Claude Fauchet, 1530-1601, creator of the history of literature: Antiquitez Gauloises et Françoises (1579-1601); Recueil de l'Origine de la Langue et Poésie Françoise.

† Etienne Pasquier, 1529-1615: Recherches de la France (1560) especially Book VII. and VIII.: studies on the origin of the language and literary history.

‡ J. Périon: *Joachimi Perionii dialogorum de linguae Gallicae origine ejusque cum Graeca cognatione libri quatuor*, 1554. Henri Etienne: *Traicté de la conformité du langage françois avec le grec*. Guichard: *Harmonie étymologique des langues;* and along with him Thomassin: *Glossarium universale hebraicum*. They derived all modern languages from Hebrew. Duclos and La Ravalière maintained that French is a mixture of Latin and Celtic.

ducted the teaching of French literature with incomparable superiority at the Sorbonne, but who represented it on its classical and literary side only. The romantic movement in the second quarter of the nineteenth century, with its tinsel paraphernalia, its fantastic vagaries about mediaeval chivalry and pageantry, its love of antitheses, its admiration for ancient ruins, abbeys, and feudal castles, its attempts at resuscitating old forgotten lore, proved greatly instrumental in making the attention of the literary world revert to the old French epics—*the chansons de geste*—the romances of bygone ages and to the poetry of the *trouvères*. But romanticism was far too effervescent and too hot of its nature to be capable of brooking the discipline of the patient and laborious methodical study that was practically the only means of procuring access to these venerable literary treasures. When August Immanuel Bekker (1785-1871) had unearthed the Provençal version of the Fierabras, and had followed up his edition of this work—published in 1829—by divers fragments of the other old French poems, his publications proved quite a revelation to the majority of their readers. And when Paulin Paris—the father of the illustrious Gaston Paris—a good while before the Government created, on his special behalf, the chair of French Mediaeval Literature (1853), was obliged, by the post he was then holding at the " Bibliothèque Nationale," to daily peruse a number of old manuscripts, he was delighted to find himself in permanent contact with those venerable *chansons de geste* and their monotonously mellow assonances, with those admirable romances of King Arthur and the Round Table, the existence of which was in those days hardly as much as conjectured. The amiable scholar, anxious to make congenial minds share his enthusiasm, hastened to lay those treasures before an astonished and enraptured public. It seemed, indeed, as if another Columbus had discovered another New World. The literature of Old-French was now definitely drawn into light. However, the philology of the Romance tongues, which alone was capable of imprinting the truly scientific stamp on the study of these old documents, was as yet unborn. The honour of having been the harbinger of its advent is due to a poet of Southern France: François Raynouard. The imperishable glory of having brought it into the world, been its first sponsor, and fostered its babyhood, belongs to a German professor, Friedrich Diez.

In 1816 Raynouard published the first volume of his " *Choix des poéses originales des Troubadours*," and in 1838, two years after his demise, the first of the six volumes of his " *Lexique* " was published. He was the first to formulate the rule for the declensions in the *langue d'oc* and the *langue d'oil*, that most interesting relic of ancient Latin declensions. However, he made himself at the same time responsible for the mistake of attributing to the Provençal tongue—his mother tongue—the prerogative of primogeniture over all the other neo-latin languages, a priority which *factu* it had by no means. Moreover, he proclaimed it the only genuine Romance tongue extant, sole daughter of the mother language and mother herself of all the others. Goethe, who took the keenest interest in Raynouard's work, made an attempt, in 1818, at persuading a young philologer, Friedrich Diez, to give it his serious attention. Diez was then on his pilgrimage to Weimar. It did not take him long to learn to admire and to appreciate the beauties of Provençal poetry, and as early as 1826 and 1829 he published his first two books on the life and works of the Troubadours. Some time after, Jacob Grimm, who by that time had laid the foundations of Germanic philology, initiated Diez to the truly scientific method, the only permissible, nay possible one in the pursuance of this kind of study. Diez started work forthwith and applied himself to the study of the Romance languages with a display of inventive genius and power of self-restraint, which were really wonderful. In the course of his long and serenely smooth career as a professor at the Bonn University, Diez wrote two works, two perennial monuments of glory to a man whose erudition was second to his modesty only, whose leniency towards others was surpassed only by his severity on himself. These works are the "*Grammaire comparée des langues romanes*" and the "*Dictionnaire étymologique*." With these two books the foundation of the philology of the Romance tongues became an accomplished fact. Not only was the course it had henceforth to follow ready-traced, but two admirable gateways had been opened for the workers to enter.

Since then the number of students that have enthusiastically followed this new, attractive and promising course has been steadily on the increase. In Germany there are nowadays professors of Romance philology lecturing on Old French to audiences of hundreds of students. Some of the so-called "Séminaires romans" have grown into real linguistic laboratories, issuing every year a considerable number of theses and dissertations, in which all the details of literary criticism and historical grammar are more or less felicitously discussed. Periodicals and special reviews have been started in such large numbers as to give rise to unsound and undesirable competition. In France itself, where the history of the language and mediaeval literature have only recently been added to the programmes of "lycées" and "collèges" (secondary schools), the host of romancists is less numerous. But the eminent masters, those who are now defunct as well as those who at the present day so gloriously represent Romance philology at the "*Collège de France*," at the "*Ecole des Chartes*," at the "*Sorbonne*:" Gaston Paris, Arsene Darmesteter, Paul Meyer, Joseph Bédier, Petit de Julleville, Morel-Fatio, Léon Gautier, Victor Henry, F. Brunot are in themselves worth an army.

* Completed now by that of Meyer, Lüske, and by Gröbler's "Encyclopédie."

In France, Auguste Brachet* was the first to make the results of Diez's investigations accessible to the general public, and to introduce rudimentary groundings of philology into secondary schools. Léon Gautier,† professor of paleography at the "Ecole des Chartres," did the same thing for the Chanson de Roland. Under the auspices of the indefatigable Mr. Godefroy the first "Dictionnaire complet de l'ancien français" was set on foot and is now practically completed. The great Littré composed his world-famous dictionary, which, though only part of the huge pile of valuable works sent into the world by this encyclopaedic genius, is in itself sufficient to secure immortality to the author. It is a work that daily renders the most signal services to the most eminent philologist, as well as to the modest beginner, who is called upon to consult it. And ever since Gilliéron, in conjunction with a staff of scholars, inaugurated the study of the various dialects and patois, this interesting new departure, which has now become an indispensable element of all serious scientific philology, has been carried on with great industry and crowned with brilliant successes.‡ Among the modern philological apparatus his "Atlas linguistique" has become an instrument second only to the steadily growing collection of gramophone records, on which the relics of almost extinct dialects and patois are preserved.. In short, Romance studies are flourishing and in full swing everywhere. Each new copy of the overwhelming profusion of linguistic periodicals brings a fresh problem or is the harbinger of a discovery. The libraries, archives, and muniment rooms have surely not yet given up all their treasures, and any amount of texts lie waiting for capable editors. The method has been definitely laid down and established; as far as that is concerned, nothing remains to be either discovered or improved upon. But this method has as yet been applied to a fraction only of the available stock, and after deduction of the achievements of the great masters among the romancists, plenty remains to be done. There are attractive jobs left, and workmen from all parts of the globe will be welcome to them. But I must come to the point now after this preliminary ramble. Taking it for granted that the study and the teaching of French at a university is essentially a branch of the study and the teaching of Romance languages, I think it is but right, in teaching French, to follow the method pointed out and prescribed by the great romancists with regard to the neo-latin languages jointly. This method, the only one compatible with scientific philological tuition, is the historical method. To trace, for each of the sounds constituting a syllable, for each of the separate forms assumed by a word, for each of the acceptations that it derives from colloquial and technical usage or from literary tradition, for every form of speech, about the meaning of which modern usage leaves us in

* A. Brachet: *Grammaire historique de la langue française; les Doublets; Dictionnaires étymologique de la langue française.*

† Léon Gautier: *La Chanson de Poland, texte critique, traduction, etc.*

‡ Gilliéron et Mongin: *Etude de géographie linguistique.* Paris, 1905.

the dark, for all the various and not unfrequently contradictory syntactical phenomena—to trace for each of these its origin and its age, to recount moreover the history of their development and successive alterations, their external and internal evolution—that is the task every philologist and every professor of French has to accomplish. It would take me too long to expand here upon the part which psychology, physiology (experimental phonetics), * sociology and even physics have come to play of late in linguistics, which at the present day has grown almost into a kind of universal science. A wonderful and admirable book has been written on this subject by a fellow-countryman of mine,† a book that no philologist will henceforward be able to do without.

This historical method has been universally adopted in foreign universities. In Holland it was introduced and most admirably inaugurated by Professor Dr. A. G. van Hamel, a romanist of well-nigh European fame, one of the most elegant, if not the most elegant, scholar Holland has ever possessed, and whose sudden and untimely death in 1907 has left a most regrettable void in the ranks of Dutch linguists, critics, and historians; a man of letters besides, whose every sentence that dropped from his pen, whether in Dutch or in French, was of the most exquisite symmetry and finish. To his valuable, delightful, and instructive writings I am gratefully indebted for the staple of the information and data wanted for this lecture. One of my sincerest regrets is that it has not been my privilege and good fortune to be more than an indirect pupil of his. For a romancist in general and for a professor of French in particular, the historical method is comparatively simple in its application. He has a firm basis to stand upon and an historical starting-point to go ahead from, viz., Latin. Not so much classical Latin, the so-called *sermo eruditus* or *perpolitus,* the written language of the Romans and the language of Cicero, but popular Latin, the *lingua rustica*, or *sermo plebejus, pedestris, cottidianus, castrensis*, the spoken language of the Roman people, a language as old as the "lingua latina" but living alongside of her dignified and stately sister as the usual, spoken idiom, the every-day colloquial parlance, the speech which the Roman legions, the representatives of government from the metropolis, and the numerous colonists gradually spread broadcast throughout the provinces of the Empire.

In several of these provinces as, for instance, Italy and Sicily, Gaul, Iberia, Retia, Dacia, this popular idiom has gradually evolved the Romance dialects, from which have sprung, *via* numerous successive alterations, the Italian, French, Provençal, Catalonian, Spanish, Portuguese, and Roumanian languages and the Retoromanic dialects. In fact, all these neo-latin languages are nothing else but popular Latin differently pronounced. It is a

* Abbé Rousselot: *L'enseignement de la prononciation par la vue* (*La Parole* 1901-1903). Zünd-Burguet: *Méthode pratique, physiologique et comparée di prononciation française.* Paris 1902.

† J. van Ginniken S.I.: *Principes de linguistique psychologique.*

great pity, indeed, that the forms of popular Latin, which have come down to us through the intermediary of inscriptions, ancient glossaries, and memorandums from grammarians, are so limited in number. Nothing short of a comparative study of all the Romance tongues will, in certain cases, enable the investigator to retrace and reconstrue a phonema, a word, a grammatical form, a syntactical phenomenon as they have actually lived in the mouths of the ancient Romani. In such cases he has to draw his conclusions as to the nature of the tree from the nature of the fruit it has borne. But the monuments of classical Latin, combined with the relics of Low Latin are a precious and material help to the philologist in his studies and investigations. By Low Latin we understand the result of attempts at writing classical Latin, made by illiterate scribes of post-classical times, who, knowing popular Latin as thoroughly as they were ignorant of the highly synthetic language of Cicero, repeatedly made slips, behind which the *lingua rustica* peeped round the corner. A great advantage, and one which is a distinctive feature of French philological study, is the comparative oldness of the linguistic and literary monuments of the language, the large number of muniments and cartularies stored in the various archives, and the motley profusion of mediaeval literary productions. Whereas the oldest Provençal monument does not take us back further than the 11th century, whereas Italy and Spain have neither of them anything to show as remote as even that, the oldest French texts hail from the 9th century with the so-called *Serments de Strasbourg,* from the 10th and the opening years of the 11th with the *Cantilène de Sainte Eulalié*, and the *Poèmes de Clermont*. These dates must, of course, be still far in advance of the very beginnings, the baby-prattle of the language, there is no doubt about that; but still these interesting landmarks, which put us face to face with a few of the oldest instances of phonetic transformation, enable us to form at least an approximate idea of what there may have been before, when Old-French was no longer popular Latin and popular Latin not yet Old-French. Making popular Latin our basis to operate from, we shall have to investigate the possible influence, exercised on primitive Romance by the speech of those nations, into whose countries popular Latin was imported or by the languages of the foreign tribes that afterwards invaded the romanised provinces. We might, for instance, ask the question: Was the influence of the language of ancient Gaul, *i.e.*, Celtic, a factor of any potency in the formation of French? Or: Of what nature were the Germanic influences that manifested themselves after the Franks had invaded Gaul? These two questions have been solved in a general way, since nowadays it is a mere truism that, first, the hypothesis of those would-be philologers of the 18th century, whom Voltaire sneeringly calls "Celtomanes," was a mere delusion and a craze, and secondly, that the vocabulary of French contains upwards of 800 words of manifestly Teutonic, *i.e.*, Germanic, origin. Still, it is not less true that even in these two seemingly simple questions there are minor problems to be found fully worthy of the philologer's research.

When arrived at the first great literary period, viz., the 12th and 13th centuries, we feel utterly at a loss, what to pick from the huge profusion of texts, for our study of that fine *langue d'oil*, which Brunetto Latini* called: "*La Parleüre la plus délitable qui soyt au monde*," a statement repeated by Martino da Canale,† where he says: "*Le langue françoise cort parmi le monde et est plus délitable à lire et à oir que nule autre.*" A fine language indeed it was: a language possessed of a system of declension and conjugation that abounded in harmonious forms, regularly sprung from Latin; a language which, in spite of the multiplicity of its dialectical varieties (in fact every author had his own!) stood conspicuous for its marvellous grammatical unity, its elegance and the supple pliancy of its forms; a language, in short, the loss of which all the dainty refinement of modern French has as yet never been able to make up for. Then, on the threshold of the modern French period, during the era covered by the Renaissance and its sequela, we see the language ruthlessly invaded by classical Latin, which, while doing it the kind turn of swelling its vocabulary, foisted upon it a large number of artificial, merely frenchified Latin forms; spoiled for ever its phonetic orthography, and transferred supreme authority with regard to speech from the mouth of the people to the edicts of sifting and systematising grammarians. Later on we notice the literary, and along with it the national, influence exercised on French by Spanish and Italian. After that, towards the middle of the 17th century, we stand in the awful presence of a brilliant body, the "*Académie Française*," which, after laying hold of the ruling power, imprinted on the language of the great authors of the golden era the stamp of absolute law, thus ostensibly dividing the language of the lettered world from the speech of the vulgar. Finally, in our own days, we are witnesses of the fact that this demarcation is gradually becoming more and more vague and blurred, so as to be practically obliterated. In fact, the ever-increasing importance allotted to the living language has drawn us so forcibly towards the popular parlance, that not infrequently we are guilty of injustice towards the literary language. It looks as if we resented the fact that it has for such a length of time engrossed and monopolised the entire attention of philologers; and that, in certain centres, it was considered to be the only language that was worth being studied. We see the men of letters dive into the popular speech, thence to draw their smartest and most picturesque similes; they borrow from it many a quaint image or expression, they call back to life vocables which had fallen either into desuetude or oblivion; they coin new words and compounds; they handle their periods with a

* The famous tutor of the more famous Dante Alighieri.

† He translated into French the "History of Venice," which he had written in Latin.

skill that often verges on over-refinement, but which never fails in making the suppleness of the idiom stand out in bold relief; they strive after novel originality in the choice and the linking together of words, and by so doing inaugurate a new future of vitality, expansion and transformation on behalf of their admirable mother tongue, which never yet lost a whit of its pristine buoyancy.

All this has to be related in full detail, proceeding step by step, from sound to word, from word to grammatical sentence, from sentence to literary phrase. In the history of words, the various alterations in form and meaning will have to be considered; in the history of the sentence the order of words and the linking together of clauses will have to be discussed. From what goes before it becomes clear that the professor's *modus operandi* must of necessity be guided by the subdivisions established by Romance philology.

The basis to start from is the history of sound, *i.e.,* phonetics. The vocalism and consonantism of Latin will be the starting point, the up-to-date Paris pronunciation along with the pronunciation of the patois is to be our final goal. The transition from one phase to the other has to be studied and explained, and due attention must be given to the successive intermediate stages. Diez has proved, and his successors have borne him out, that the phonetic changes in the Romance languages, as well as everywhere else, are accomplished conformably to certain natural laws, which are quite as reliable, unalterable and philosophical as the laws of physics and of chemistry. These laws prevail during a given period and within a special area; but then and there they prevail in an absolute manner. A few simple examples will make this clear. When *c* hard (palatal, *i.e.*, $c = k$) of Latin, standing before *a* or *au* changes in French into the sound represented by the group *ch,* all the words of the time that are in the same conditions follow suit. Thus we find that *catus* becomes *chat*, *caro* becomes *chair*, *calor* becomes *chaleur*, *caballum* becomes *cheval*, *cantare* becomes *chanter*, *causam* becomes *chose*, *caulem* becomes *chou*. Such words as have not undergone this change are borrowed from the Picard or Norman dialects or from another Romance language. At the time when the tonic *e* of vulgar Latin is diphthongized into *ei*, all the sounds of this nature, in this condition, undergo the same change, *e.g.*, *habere* becomes *aveir*, *regem* becomes *rei*, *plenum* becomes *plein*, *frenum* becomes *frein*. When afterwards, in certain parts of France, this diphthong changes into *oi*, except in cases when it is followed by a nasal, *aveir* becomes *avoir*, *rei* becomes *roi*, but *plein* and *frein* remain in *statu quo ante*. When, again, we find that, for instance, *fenum* becomes *foin* and *avenam* becomes *avoine*, the reason for this anomaly is, that these words were probably borrowed from the Eastern dialects (Wallon, Lorrain, Bourguignon, Champenois), in which *ei* always became *oi*, even before a nasal. It must be kept in mind that these laws apply solely to the words of so-called popular or primitive formation, which constitute the fundamental stock of the language, and not to the vocables of learned or artificial formation, which were borrowed straightway, in barely frenchified form, from classical Latin, and with which scholars of all times after the Renaissance have consecutively enriched the vocabulary.* But wherever these laws prevail they do not allow of any exception. Every apparent exception is a fallacy in its way and due, as shown above, either to the interference of some other phonetic law, thwarting the one under consideration, or to some psychological influence or other. Thus, again, Latin *a* placed at the end of a syllable and being stressed, changes into *ai* before a nasal. When now alongside of *granum,* which has given *grain, manus* becomes *main, amat* becomes *aime, lanum* becomes *laine, famen* becomes *faim,* we find *canem* becoming *chien,* and *ligamen, lien,* this peculiarity is to be ascribed to the fact, that in the latter case the nature of the *a* had been previously acted upon and modified by the guttural *k* and *g.* And again, when the French word *grief* with its diphthong *ie,* which presupposes short *e,* in classical Latin, tallies badly with the actual Latin *grave,* because *grave* could not have resulted in anything else but *gref,* as *navem* has resulted in *nef,* and *trabem* in *tref,*† then the fault lies with the ancient Gallo-roman tongue, which had superseded the classical adjective *grave* by *greve* with the visible, instinctive intention of drawing it closer in form to two well-known and much-used adjectives, *leve* and *breve,* with which it bore a great resemblance of sound. This phenomenon of instinctively drawing together and associating forms which show some similarity or other, goes by the name of "*action analogique,*" and is one of the capital features of the second chapter of historical grammar, of morphology. The most important class of apparent exceptions to the laws of phonetics are those due to the action of analogy. It is a natural tendency of making alike in sound such words as are associated in the speaker's mind in consequence of similarity of meaning or of function, or, more rarely, in consequence of a partial resemblance in sound already existing. When due attention is given to this power of analogy, this craving in the popular mind for uniformity, this tendency to levelling, we might almost call it, we shall more easily succeed in grasping the curious history of French declension and conjugation. The procedure will be best explained by quoting a few examples. *Reddere* instead of *redre* becomes *rendre* through analogy with *prendre;* give and take being naturally associated (similarity of meaning). We still say in our days, *je peux,* etc., *nous pouvons je veux,* etc., *nous voulons.* Similarly, Old-French said phonetically: *je treuve, tu treuves, il treuve, vs trouvons vs trouvez, ils treuvent; je demeure* etc., *nous demourons;* but in these latter cases the vowel has been

* See supra.
† Found in *entrave, entraver.*

made uniform by analogy in all parts of the verb. In the one we find carried *ou* throughout, in the other *eu* (similarity of sound).

Sit gives *soit*, and *habeat* should give *aiet*, which, however, becomes *ait* on analogy of *soit*, both being the present subjunctive of an auxiliary verb. The present participles of all verbs now end in *ant*, which properly belongs only to the first conjugation from *-antem*. The other conjugations had *-entem* or *-ientem* (similarity of function).

Plico, plicamus should give: *je ploie, nous ployons*; on the analogy of *je prie, nous proyons*, it became in Old-French: *je plie, nous ployons*. Hence we have now two verbs: *je plie nous plions* and *je ploie, nous ployons* (similarity of sound). It will be observed from the above examples that analogy has been especially busy in altering the conjugation of verbs.† Now that phonetics and morphology have been seriously studied on scientific principles, a stop has been put to the sad plight to which etymology was at one time reduced by a number of would-be inventive geniuses, who made it their sport and pastime. It was treated as if it was some sort of divining art, a guessing at riddles, at which Voltaire could sneer fairly cheaply, when he said: "*Les voyelles n'y font rien et les consonnes y font peu de chose.*" Ménage, the tutor of Mme. de Sévigné, was a great sinner in this respect. He derived the word haricot (kidney bean) from Latin *faba*, via the following fantastic intermediate stages; *faba—fabaricus — fabaricotus — aricotus — haricot*. *Aufaine*, which means a charger, he derives rightly from the Spanish (through Arabic): *alfana*=a horse. But to connect it with Latin *equus*, he forges the following air-built filiation: *equus—equa—eka—aka—haka—faka—facana—fana*, and with the Arabic article before it: *alfana*. Indeed, one of Ménage's antagonists was right when he sent him the following quatrain:

> *Alfana* vient d'*equus* sans doute;
> Mais il faut convenir aussi,
> Qu'en venant de là jusqu'ici,
> Il a beaucoup changé en route.

He derived the adjective *jeune* from the noun *jeune* (fast) because he said, youth is the dawn of life, when man has not yet broken his fast! At present we know that *faba* could never have resulted in anything but *fève*; that the sounded *h* in *haricot* is sufficiently indicative of its non-Latin origin (there was an old verb of unknown origin, haligoter=to chop up), and that the words *jeune* and *jeune*, which make a rhyme in modern French, had nothing in common in bygone ages, when the former was either *jovene* or *juene* (juvenem) and the latter *jeüne* (jejunum). The following example will prove the importance of morphology in the etymology of words:—

* Margaret S. Brittain, M.A., *French Phonetics*. Clarendon Press, Oxford.

As soon as Arsène Darmesteter had discovered the law, that is named after him and which says that "every Latin pretonic, non-initial vowel, and every post-tonic vowel, with the exception of the vowel *a* (which becomes *e* mute), falls out,"* it could be proved that in Old-French such verbs as *aidier*, from *adjutare* (where *u* is the pretonic), were regularly conjugated with their *u* in the strong forms (where the ictus falls on the *stem*): *j'aiu* (adjuto), *tu aiues* (adjutas); and without it in the weak forms (where the ictus is on the *ending*): nous *aidions* (adjutamus) vous *aidiez* (adjutatis). Well, then, the etymologists had been trying for ever so long to find a quite plausible and satisfactory etymology of the verb *diner*, but without definite success. Quite a number of origins had been suggested: *decenare*, *discenare*, *deescinare*, *esca*, *die cenare*, nay, even, *destinare* and *decima hora*, not to speak of the Greek δειπνεῖν. And what is the conclusion Gaston Paris has arrived at by means of Darmesteter's law? Briefly this: The popular Latin verb *dis-junare* (for dis-jejunare), which gave regularly in its strong forms: *je desjun* (disjuno), *tu desjunes* (disjunas), was bound to make in its weak forms—consequently upon the falling out of the pretonic vowel: —*nous disnons* (disjunamus), *vous disnez* (disjunatis), and in the infinitive: *disner* (disjunare). So, in the olden times people said: *je déjeune, il déjeune*, but *nous dinons, vous dinez*. Analogy has been at work on both sides. The strong forms have bequeathed to us an infinitive, which is *déjeuner*, and which did not exist of old, and the regular old infinitive has given to the world the forms: *je dine, tu dines, il dine*, which did not exist either. And so it has come to pass that the words by which, in our days, we denote two distinct meals, have practically the same origin, and have in bygone days implied the same detail of daily life, *viz.*, the first meal that was taken in the morning after getting up.

Narrowly knit up with the history of the form of words is the history of their meaning, *i.e.*, the study of the successive alterations words have undergone in their meanings. It is obvious that this department, "la sémantique," or, as English has it, semasiology, or semantics, or, as Littré calls it "pathologie des mots," is of the highest moment with regard to the psychology of nations. But being part and parcel of lexicology rather than a chapter of historical grammar, it is not well possible to expound and discuss it in the systematical way grammatical problems admit of.† Yet the etymologist could never ignore it in his researches. One example will suffice to prove this. Let us take the word *danger*, which is practically synonymous with *péril*.

* In other words: All atonic finals are dropped except *a*, which becomes *e* mute. All atonic counterfinals are dropped except *a*, which becomes *e* mute, *e.g.*, the Latin word *bonitatem* becomes in French *bonté*. In this word *a* is the tonic, *e* the counter tonic, *e(m)* the final, and *i* the counterfinal. The tonic has the main stress (ictus, tempus forte), the countertonic the secondary stress; the rest is atonic.

† See for this: Arsène Darmesteter: *La vie des mots*. Paris, Delagrave.

For this reason a certain temptation exists to look for connections with the Latin *damnum,* and to locate it in the same family as *dommage*, which was in Old-French, as it is now in English, *damage*. However, in the language of the Middle-Ages, *dangier* has a sense different from what it means nowadays. Then it was equivalent to *pouvoir, présomption*. Un homme dangereux meant then: un homme impérieux, volontaire, *i.e.*, self-willed, authoritative, overbearing. Well, this circumstances combined with the form *dongier,* which is frequently met with in manuscripts, proves that *danger* has come from the same etymon that has given *dame* and *domaine,* namely, the Latin *dominum*. It has nothing to do whatever with *damnum*.

The third chapter of historical grammar, and the one that has as yet not received the same degree of attention as the other two, is syntax. The method will be the same here as for the other sub-divisions: the past must explain the present. One example will do to show the kind of work we have to occupy ourselves with. Let us take the past participle of a verb conjugated with *avoir* and its agreement with the *direct object* in case the latter precedes it. This rule is a stumbling-stone to all strangers beginning to learn French. Well, the history of the language gives it full explanation. In olden times the part played by the verb *avoir*, accompanying, as an auxiliary, the past participle of another verb, was not so vague as it is now. *Avoir* in those days had still its original value of *posséder*. Thus is was quite natural to say: *j'ai la lettre lue*, in about the same spirit as one would say: *j'ai un beau livre*; or: *il a deux ennemis morts* for *il a mort (tué) deux ennemis*. Later on, when in constructions like these, *avoir* had become more and more a mere auxiliary, a symbol to make the periphrastic tenses of a verb with, the mind, whenever the object of the action was mentioned, before the action itself drew the main attention to the direct object and stuck to the habit of giving to this past participle the characteristics of gender and number that distinguish this object.

These are the extremely sketchy and rapidly traced outlines of the study of French at a foreign university, and of the method to whose strict discipline the student has to submit. For phonetics and morphology this method is the deductive method. The starting-point is to be taken *not* at the sounds of modern French, where resemblances as well as multiple diversity would be apt to lead us on wrong tracks, not at modern grammatical forms either, which have become too uniformly blurred, but at *popular Latin*, the *lingua rustica* with its clear and simple vocalism, its rich and logical forms. From there we leisurely descend the current until we reach the language at its present stage. With regard to syntax, it might be recommended, because it is more practical, to proceed inversely, ascending from the present usage to preceding stages, comparing carefully what actually is with what formerly was.

I think I may now conveniently pass to literature, and devote a few thoughts to this second great branch of the study of French. I need not be long here, because we are *in terra cognita*, French literature being highly appreciated by all persons of culture, and quite a series of names of renowned foreign scholars and critics having been associated with all its phases for a great length of time. I will strictly confine my remarks within the bounds of what appears to be the special task of higher education. It seems to me that, with regard to the study of literature, the task of higher education ought to be *not* to cover the entire vast area of French literature from beginning to end, and to relate, in a compendious synoptic manner, the whole of its history, but either to comment in a most thorough-going way upon any one special department of literature: the epic, the drama, the fable, the novel, and to scrutinise its origin and evolution—a *modus operandi* highly advocated by the famous late lamented F. Brunetière—or, to study in its veriest detail, a period, part of a period, and the life and works of some standard writer. Such is the method generally favoured and adopted at Paris, where the programs of the *Collège de France* and the *Sorbonne* put before the students every year a new and strictly circumscribed subject. Not to speak of the impossibility for foreigners ever to raise themselves to the level of the eminent French masters, who by the manner alone in which they speak of the literature of the past, contribute no end of brilliant material to that of the future, we must never forget that the task, *qua talis*, of a professor of French at a university outside France, is very different from the one a son of the land has to accomplish before an audience of Frenchmen. There are a great many things which the latter may safely suppose to be known, but which the former must necessarily mention and frequently even comment and expatiate upon. That is why, in our case, it will be found useful and reasonable to travel through the history of literature period after period—literature has itself imprinted a special stamp on each of the centuries that make up its history—but, in order to avoid the danger of making foul work by driving too many ploughs at once, it will be found indispensable as well to pause and make a stay from time to time at some special work of note, and to study it exhaustively by submitting it to all the delicate tests and operations of historical criticism. In following this method there is, however, one thing to be feared, *viz.*, that one gets simply overwhelmed by the immensity of the task as well as by the profusion of the material. The scientific problems found in the history of French literature are as important as they are numerous. There are, in the Breton cycle, for instance, the romances of the Saint-Graal and its mystic band of guardians and questers, the filiation of which no investigator can trace but at the cost of interminable peregrinations, equal almost to those performed by the heroes of the tales he is studying. Then there are the "Fableaux," those imperishable monuments of the "esprit gaulois," which are knit up with ancient oriental literature, and even with that of India. Then, again, there is the epic poetry of the Middle Ages, whose history has had to be revised, recast and partly rescinded, since the results of much scientific research accomplished by the famous Italian, Pio Rajna, have rendered it highly probable that, though French in form and development, it is Germanic in its origin.* What a pile of manuscripts to be deciphered, tabulated and indexed; what a heap of texts to be classified and epitomised; what a quantity of foreign literature to be perused, compared and studied, to obtain what is worthy of the name of scientific result! And when the Middle Ages have been successfully coped with, there is the literature of the 15th century in front of you, a transition period bristling with difficulties, and the texts of which are not infrequently even harder to locate and to classify than the majority of the mediæval ones. After the 15th you plunge into the 16th century, which, from beginning to end, will bring you into contact with the literature of the Greeks and Romans, wherever you wish to satisfactorily explain its character. Safely landed now in the domains of the modern era, you might think that your path will henceforward be a smoother one. Nothing of the kind. Only a strictly scientific method of teaching will enable you to explain the great writers, of whom several have bequeathed or will bequeath immortal works to posterity. What gropings, what perplexities have not preceded the establishment of the authentic text of Pascal's Pensées! That the latest edition of this work, that of Brunschwigk (1895), is at the same time the latest proof, and a decisive one, that it is impossible to fix upon any classification of the Pensées! What an amount of research work was not required to write the biography of Molière!

A scholar of the standing of Ernest Havet has not deemed it below him to give to the world a classical edition of some few of Pascal's "Lettres provinciales"; and what a delightfully novel series of subjects did the great German professor Tobler inaugurate when, about twenty-five years ago, he proposed to the students of his "Séminaire roman," to take in hand the Esopian fable in the Latin Phaedrus and sedulously to follow its track *via* the Romulus and the various mediæval Ysopets, up to that admirably original work that wound the wreath of immortality round the brow of La Fontaine! The fresh breeze of modern philology is now blowing through the literary faculties of all the universities. Times have, happily, gone by when it was generally believed that only Virgil and Livy, Homer and Sophocles were worthy of the precincts of the university, and that Shakespeare and Molière, Goethe and Victor Hugo were only good enough to be pleasantly talked about on winter evenings, by a talented and fashionable lecturer, for the benefit and edification of a select public of society ladies and gentlemen in evening dress. The classrooms of the secondary schools also were places where these modern authors could be appropriately discussed, read and explained and usefully made into intellectual pabulum for school boys and girls. But to admit them at the University was a thing that could not be thought of. Happily, all this has been altered.

* P.-Rajna: *Origini dell' Epopea francese* (1884).

and in our days the chairs of modern languages and their philology and literature have become scientific and academic centres of the highest order.

I have one point left now, about which I should like to say a word before concluding. It is literary criticism. With regard to literary criticism, which ought to have its legitimate place after historical research, we must be very cautious. Trustworthy authorities, among whom is Prof. Van Hamel, are of opinion that higher education should be very chary of it if it wishes to avoid the pitfall of commonplace triteness. A literary work, it will be admitted, is not only a linguistic or an historical monument, it is at the same time a work of art, and a work of art can be thoroughly grasped and known only after one has succeeded in realising and appreciating its aesthetic value. Now, literary criticism is in itself an art rather than a branch of science. A man may cultivate it if endowed with aesthetic perception, but it cannot be taught; it presupposes a series of strenuous studies, but the mere fact of being a scholar is not in itself sufficient to make a man a critic. No man, however learned, can be pitchforked into a literary critic; it is the gift again that does it; like the true poet, *Criticus nascitur non fit*. Then—and this remark seems to be particularly well founded where foreign literature is brought into play—we find ourselves often lacking in the indispensable criterium for making high-wrought criticism. There exist, of course, a certain number of universal laws, dictated by the understanding and by taste, by which every literary work, no matter from which country it emanates, has to abide. As soon as we take it for granted that these laws either condemn or approve, claim admiration or taunt with reproof, neither the personality of the critic nor his nationallty is of the slightest consequence. But alongside of these essential principles, there is no end of æsthetic ideas and notions, the value of which is of a purely relative, transient, local or personal nature. In every serious literary work there are quite a number of specific elements, in the explanation of which extraction, temperament, habits, *milieu* and ambitions of some special nature or other are to be taken into account. A foreigner must needs have great difficulty in grasping all these details, and when he has succeeded in getting a clear understanding of them it is hardly likely that he will dare to criticise. It is all very well for an " académicien " of the standing of Nisard to pass judgment on the literature of his country conformably with his personal academical ideal, and to proclaim subordinate to the great literary productions of the Golden Era all the writings that have either gone before or come after them. But in an unpretentious student of French, teaching French literature at a foreign university, it will be wisdom not to swell the host of critics and to make historical study and treatment of his subject the be-all and end-all of his task. I need not mention, I am sure, that he will be perfectly welcome and at liberty to voice and ventilate his personal views and appreciations on any literary production he has made an object of investigation. But let, in his teaching, the historical element be paramount. Historical studies in themselves are not criticism, it is true, but they are the only high road leading to critical competence and efficiency, and with the majority of us they had better take its place.

Even in France literary criticism has been for a considerable length of time one of the side-lines of history. Sainte-Beuve, one of its most illustrious representatives in the first half of the 19th century, proceeds, when he studies a writer and his works, from the man to the works. I mean to say, he tries to get an insight into the personality and life of the author, and of the various influences to which the author has been subject, and then traces back the work under consideration through each successive process of its genesis. This is the natural method. Taine, one of Sainte-Beuve's disciples, applies to literature the scientific and naturalistic method, following which he regards all literary work as the necessary outcome of certain causes, *causae praedisponentes* as well as *causae proximae*—capable of being traced by proper and methodical investigation. These causes are: nationality, condition in general, such as climate and country; political and historical circumstances, milieu, race, family; and the psychological moment. Taine makes, so to say, a kind of mathematical diagnosis (*sit venia verbo*!) of it. Paul Bourget, the originator of psychologism in romantic literature as an anti-naturalistic reaction, strives after defining the intimate relation and affinity that exists between the author and the special group of readers who fancy his books in preference to all others. However different, these critics all agree in taking their starting-point from the principle that objective historical analysis ought to have the precedence over personal appreciation, and that there is more genuine gratification and enjoyment to be derived from *understanding* a thing than from *censuring* it. This goes pretty far to prove that a man ought to compel himself to the utmost caution wherever, not being a master of criticism, he has to teach the history of a foreign literature as a science. Everyone of us may have happened to hear a person speak more or less disparagingly of the classical dramatic works of Corneille and Racine, because you know they are miles away from Shakespeare's plays, or Schiller's or Goethe's; they do not strike one at all as being so exceptionally good and nice; they seem to be so bald, so little amusing, there is so little lively action in them and so many interminable monologues! Or, that an Aristarchus *ejusdem farinae*, in speaking of any one of the grand-masters of the French novel, asserts, with a knowing wink, that in such-an-such a novel the author goes decidedly off the metals or sadly overshoots the mark. Well, instead of showing fight and entering upon a debate, which probably will be only as aggravating as it is useless, the best course to be taken is to say that, after all, those French authors are free to write as they please, being their own masters in their own country. While pursuing the study of French in a serious and strictly scientific manner, a teacher of this subject can never be forgetful of the fact that the study of French literature is at the same time an art, a most delicate and exquisite art, because its object is one of the most artistic languages that have ever been spoken. Language is made up of music as well as of thought, and if it is true that there is nothing to equal French thought in clearness and limpidity, there is scarcely anything to match the music of the tongue of France for harmony and mellow sweetness. Indeed, artistic study of the French language amply deserves a place alongside of its philological study; for no student will be able to properly realise its full range and depth that has not become keenly alive to its matchless lucidity and exquisite elegance; to that simple and natural diction which is so entirely its own, and which, though scorning declamatory pomposity, does in no way exclude either eloquence or lofty elevation—in short, to all those characteristic properties of thought and form, of *timbre*, modulation and tone, of rapid elocution and accentuation which make French the language *par excellence* of diplomacy and of confidential disclosure, an uproarious music in the mouth of the mob, and a reserved tremulous strain between lovers: a murmur in intimate privacy, a frank peal of laughter in the drawing-room, a thunder from the public platform. Nor can a man forget the powerfully developed artistic temperament of the French, when he has to teach their literature. What a galaxy of masterpieces! Down from the metrical romances of Chrestien de Troyes, which the whole European literary world of the 12th and 13th centuries vied to possess and enjoy, up to the most modern novels, with which the contemporary world is flooded; from the dramatic gems of the 17th century, which have graced all foreign stages, up to the plays of the present day, which form an inexhaustible stock for all the theatres of the world to borrow from; from the sermons of Bossuet to the speech of Jules Favre and the political addresses of Gambetta; from the thrilling and spirited prose of that hopeless sceptic Pascal to the delightful, captivating, philosophical and yet so mundane prose of that amiable sceptic Renan; from the ballads of that Paris ragamuffin Villon up to the latest chord from the lyre of Victor Hugo, there is one uninterrupted flow of masterpieces.*

But I feel that I must now come to a close. As what it has been my pleasure and privilege to say is but a feeble echo of what my masters taught me, especially that one, whose name adorns some of these pages, I lay no claim to originality. The time and space granted to me did not allow of much amplification, however gladly I would have seized the opportunity of expanding in some of my chapters. But if I may have succeeded in giving some notion of the ideal a professor of French ought to keep before his mind's eye, and of the comprehensive task he has to accomplish, I shall feel sufficiently rewarded for the time I spent on this modest little piece of work and the trouble I took to compile it on behalf of our Association for the advancement of learning.

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* Van Hamel.

HYMNS IN PRAISE OF FAMOUS CHIEFS.

By Rev. Johannes August Winter.

As the Pharaohs of ancient Egypt engraved in stone the hieroglyphs of their doings, so the old native chiefs also, during their lifetime, made hymns in praise of all their own brave deeds in hunting and fighting. In many cases the words and sentences used are abbreviated. I, although knowing Sesuto well, could not understand most of these words. The great *indunas,* when sitting round the Council fires in the evening, drinking beer, or together eating their most excellently cooked beef, used to half-sing these hymns of praise, or rather, speak them in a sing-song voice, all the rest quietly listening.

I could only write down fragments of them, with the assistance of one who would slowly repeat them over to me word by word. What a pity that these hymns have not been collected! They are the history of the people, and I believe trustworthy, for they would not have allowed untruths to be solemnly declaimed before so many witnesses of the very facts. Indeed, I think that they are more trustworthy than *post-mortem* history. The Government is anxious to preserve the old Bushman pictures; it ought to collect and preserve these old Chief-hymns, like that of Tulare which are a hundred times more valuable. The old grey-heads are dying out, so that it must be done quickly, and I have neither the time nor the means to record the old Moshesh-hymns.

I. Hymn of Mampuru (Son of Moukangoe).

Kgola magata-ditoto
Lekoto o 'labiloe la gara Káau ea Tebile
Methepa ka tlase metsi le se ke la noa
Tuhu ea Manaka a Tebele e inne mosela metsin
Tubats ka tlase metsi ga a nooe
Letsiku la Ba-kuena
Tse di mafsi oa di tseba
O tsamaea oa di nyakorela mekaka
Se'labana se'le 'labiloe
Moato a 'labiloe ole
Magorong a banna.

(Translation.)

The great, steps upon corpses of men—
Although wounded he still fights in the midst of the sons of Tebele.
Girls! Downwards the water must not be drunk.
The Tuhu[1] of Manaka[2] of Tebele has put its tail into the water.[3]

[1] A fierce wild animal.
[2] His sister.
[3] I have spoilt the Steelpoort-water by my killing so many.

Steelpoort downwards is not to be drunk—
The husband of Ba-Kuena[4]
He knows the good milk-cows—
He goes and looks at the udders—
He fights, when wounded,
All the feet wounded—
In front of the Council-fire-places of men.

II. Part of Hymn of Moroamotshe, Son of Mohube.

Mathung-thung a Motsha
Marole a Marotha
A matsosha phefo, Tsuane,
A Makoa, moloka-bathu.

(Translation.)

The destroyer of kraal from Motsha (Ba-Kgatla)
The dusts of the Impis of the Masotha (Bapedi)
Stirs up whirlwind of flying people, he Tsoane (Moroa motsha)
Of the Makoa (circumcision-year), safe-keeper of men.

III. Parts of the Hymn to Tulare.

Tulare o itse: Thu! Le-Palakata
Kgomo di tshabela Madikadikane
Di tshabela Mosetla tlou Linana
La g'abo Mankepeng.
Dinthoa a re tsebe ka dinaken di sele
Monu gare ki alotse ka Mongana Sepitla.
Kgogonope ea ga Ma'lodi
Tladi ea ga Moroamotshe ekhubedu
E 'loile e tima nthoa se mollo
Moitlotledi oa ga Ra-Káau
Ka molamo oa gago oa tsipi
Ka molamo o sa 'latloga Lolu
O bona Sethele Moletlane—
Mosa-tena Matima Mpa'lele—
Mutla o la oa tatagoe
Le ga'lane nao kgaditse
Le Kgomo Monepenepeng
Mypa tsa ka tsa go raka tsa go fatela lerole
Tsa gu tsenya moleten kgaditse
Kopyana la ona ki le le hubetsana
Mpya tsa ka tsa go tsela lerole
Methepa ea Makibane
Ea Makibane a Sha'leng
Ea Makibane le moganeng
Le re: Re isa kae motho o bidiketse

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[4] Se: *Ba-bina kuena-ba Mongatana.*

A bidiketse dirupe le marago
Tulare o tlotse mothaga molomo
E bile e ke ki kgomo e tsungoane
Tsumo ea dira seaba Mabuka
Bontsi bo lala le tlala.

(TRANSLATION.)

NOTE: The first knowledge of white men is not included in the Hymn, because the Chief kept this secret for himself alone.

Tulare said: Thu! Le-Palakata[4a]
The cattle fly to Madikadikani[5]
They fly into the kloof of Mosetla-tlou Lenana
Of Mankepeng[6]
The wars I do not know are those going on all sides[7]
Here in the midst (I) Sepitla[8] has driven them asunder by a Wacht-een-bietje tree—
(I) the cock of the Ma'lodi[9]
(I) the red flash of lightning of Moroamotshe,
Always extinguishing wars like a fire—
Who uses as a walking stick, him of Ra-Kaau[10]
A walking stick of iron;
With it he walks up the Lolu Mountains.
He sees Sothele of Zebediela[11]
You little boy—Matime of Mapahlele—
The hare of his father
We meet each other at Kgaditse
At Kgomo—Monepenepeng—
My dogs hunted you, digging up dust—
Drove you into the hole Kgaditse.
My dogs by making dust round you
The tail of the hare[12] became red
The girls of Makibane[13]
Of Makibane at Sha'leng
Of Makibane, refuse him[14]
Say: Where shall we go with a man so big,
Big in the loins and the hind-parts
Tulare besmeared with Witt-clay round his mouth[15]
Just as if it was a cow with a white mouth—

[4a] Thu! The voice of the first gun ever heard.
[5] Now Riverside.
[6] His sister, the tree Tenana being called after her.
[7] His impis going in all directions.
[8] The Crusher.
[9] His grandmother.
[10] Motsha.
[11] Makes a raid upon him.
[12] The Chief.
[13] Magakal.
[14] *i.e.* Tulare.
[15] Always on the war-path.

White-mouthed of an army, dividing looted cattle,
Most of them not getting anything.[16]

The above is Tulare's Hymn relating to the fighting. The following is his song, after his fighting time was past:—

Se'lola sa ga Ra-Kaau se tsofetse
Matholo ki Masi'la-Legana—
La g'abo Mankepeng.

(TRANSLATION.)

The great enemy of Motsha is old,
His knees are wrinkled, the wrinkles of the Lengana[17]
The Lengana of Mankepeng's[18] family.

IV. HYMN TO SEKWATI.

Sekwati-kwati sa Sehulabosego
Sekwati le ba banyane ba mo tseba
Ba re: Ki ena e la oa Kala-puane.
Ki Tshaba'la a Malema.
Mamosidi oa moroba oa tsebe—
Makgale kea 'laba
Tshukudu ea moroba ea naka lesu
Naka le le tsosago lesolo kgatsoatsoe.
Ea ba-Rantsodi ea Thebe—
Kgoadi e itse mola naka e lemile
Ba na ba e sukulla ba e bea go sele
Ba na ba e bea gare ga phatla ea sefela.
Sa tata-go Moikhoetsi oa Magasa.
Seale motho legonong
Ka sukeng le lesulesu
O sa ile nalo gola la masogana
A tlo uela moetsana, ka uela.
Ka bueletsa ka selepe kgaladi
A Ra-mo'laku a Rapogole.
Mola a napa a ntsiele rure
Ki be ki tlo roma sitsi-moloi.
A difela kiti mosito
Batho rea lelekoa
Re rakoa ki ba-ga-Mogolele
Lerako le sele
Re rakile mosimane emosoana oa metlakana.
A rego a thsaba
A fela a ipekenya
Byalo ka monanedi oa kotse
Bathu ba lefa ba mo utloa monati
Ba re: motho o letseke o bua Kgosin.

---

[16] *i.e.*, so many were the warriors, that only a few got looted cattle.
[17] The thorn-tree, *i.e.*, Tulare.
[18] His great sister.

Ki kgoadi ea bo-kgaitsedi
Ea bo-kgaitsedi ea Lekgolane.
Bathu le sa nthete
Ga le sa nthete ki pelo ensu
Pelo rifadi ea mogatsa sa mme.
Le lebala go reta
Le lebetste nua mogale-Kgaladi
A Makoa
A le ledisa motho
Ka rupu tsa Sekwati ka mo lelekisa
Serupa sa ba-Segolo-moshito
O o tsoago Boroa kgautlele
Mosoelesoele oa Boroa oa lla
O re: Lebellang dinong, masogana
Letlaka le la la ma'lo magolo la kgosi
La gagoe la Mohuba oa Seopela
Ngogola Bopedi le tle morokd
Lo dyela di'latlegeleng
Matlakana a tlo isa melomo
Bomogatsa noanana oa lekgoareng.

(TRANSLATION.)

Sekwati-kwati[19] of Sehula bosigo.[20]
Sekwati, even the little ones know him,
They say: That is he with the white Seala[21]
I am Malema with many assegais—
I am Mamosidi. I have a moroba[22] in my ear—
I am a Rhinoceros, I stab—
A Rhinoceros with a black horn.
I am Kgatsoatsoe, stirring up dust with my horn—
Of the Rantsodi with a shield—
I am Kgoadi,[23] when the horn was all right upside—
They turned it round to put it elsewhere[24]
They put it in the middle of the fore-head of me Sefela[25]—
Of the father of Moikhuetse[26] of Magasa
I go with men into the thicket.[27]
Into the black-black-desert.
I am legola[28] of the young man, going with him[29]
When he falls, into a donga, I also fall—

---

19 Running and driving away men.
20 Malekut *vs.* Tulare.
21 Ornament on hair from springbok skin.
22 The broad flat ear-ornament of copper of warriors.
23 A white and black bull.
24 They said that I was no Chief and wished to rob me of my Chieftainship.
25 Sefala= scraper, used for curing skins.
26 Daughter of Motodi.
27 *i.e.*, run after the enemy into his stronghold.
28 Open field.
29 *i.e.*, to the enemy.

Again and again I cut into him with the hatchet
Of Ra-mo'laku of Rapogole[30]
If he would, however, manage to run and escape me—
I would send him a fly to bewitch him—
I, the praised runner of great velocity.
Men, we are driven away.
We are hunted away by those of Mogolele.[31]
A bad drive-away.
(They say): We have driven away the young black one with his young men—
Who, when he flies,
Is still showing pride
Just like a white shield
The people are always pleased with him.
They say: A proud man, comes from the Chief—
I am the black and white bull of my sister
My sister Lekgolane—
Men, if you do not praise me,
Your heart is black—
A dark heart of the wife of my brother—
You forget to praise me.
Me, the brave Kgaladi of the Makoa—
I make the man (enemy) cry—
With the swiftness of Sekwati, I drove him.
I cut him with the hatchet which could be heard—
Running with audible steps from Baroa-Kgautlel—
Modosodesode[32] of Boroa cries—
It says: Young men, look at the big birds.
The eagle with the great eyes of the Chief[33]
Of Mohuba of Seopela[34]
Last year in Bopedi it has eaten (killed) a Moroka—
It is going to eat him amongst the young men—
The eagles will bring their beaks
To eat the men of the girl amongst the stones (dongas).

LINE BREEDING AS APPLIED TO SHEEP.

By C. Mallinson.

(*Printed in "South African Agricultural Journal," Vol* 4, *pp.* 429, 430.)

30 Of the oldest Chiefs.
31 Dikotope.
32 A bird.
33 *i.e.*, himself
34 Malekut.

SOME ANTARCTIC FRESH WATER ANNULATES.

By Prof. E. J. Goddard, B.A., D.Sc., and D. E. Malan, M.A.

(Not printed.)

THE HUMAN DIGESTIVE ORGANS.

By F. W. FitzSimons, F.Z.S., F.R.M.S.

(Not printed.)

Canadium—A Supposed New Element.—On page 225 of the preceding volume the discovery was reported of a new element, to which the name "Canadium" had been assigned. In the Annual Report of the Minister of Mines (British Columbia) for the year 1911, it is stated that authentic samples of the dyke in which the presence of platinum metals and "canadium" had been reported, were procured, and submitted, together with concentrates from the crushed material, to representative firms of assayers, to the Canadian Geological Survey, and to the British Columbia Government Laboratory. In no case were any traces of platinum metals detected, nor was there any evidence of the presence of the alleged new metal.

TRANSACTIONS OF SOCIETIES.

South African Institution of Engineers.—Saturday, April 12th: Mr. W. Calder, Vice-President, in the chair.—"Hauling from great depths": H. **Kestner.** The author discussed methods of improving the efficiency of hoisting machinery, and the conditions which obtain when hauling from depths of from 3,000 to 4,500 feet, and when hoisting with steam or electric-driven machinery.

Chemical, Metallurgical and Mining Society of South Africa.—Saturday, April 19th: W. R. Dowling, M.I.M.M., President, in the chair.—"Note on the quantitative determination of nitrous fumes in firing (cheesa) sticks": Dr. L. **Heymann.** The fumes are absorbed by a strong alkaline solution in which the oxidised nitrogen compounds are determined after reduction to ammonia. Results of the author's analyses of several well-known brands of "cheesa" sticks by this method were given.—"Gold production in relation to humanity": E. M. **Weston.** The author disagrees with the somewhat generally accepted view that the production of gold is now excessive and is causing serious disturbance in prices. In controversion of this view the author discussed the history of the rise and fall of nations as influenced by gold production, and then proceeded to enquire whether, over long periods, prices have fluctuated in sympathy with the rise and fall of gold production, or whether other factors have governed that rise and fall; whether the prices that have increased have been general or only those of certain commodities ; whether there has been a real or only an apparent expansion of gold production ; and, whether the production is not even now barely sufficient for the world's needs and threatens to become exhausted and so seriously endanger civilisation.

South African Society of Civil Engineers.—Wednesday, May 14th: F. E. Kanthack, M.I.C.E., President, in the chair.—"The Potchefstroom Reservoir": M. R. **Collins.** The reservoir was constructed in order to relieve a shortage of water in the Mooi River, and also to provide work for white people. The catchment area was 1450 sq. miles, with an estimated yield of 187 million cubic feet of water per annum. The estimated cost of the work was £20,000. In this connection the subject of unskilled white labour and the system of payments adopted was briefly discussed.

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Members are requested to notify the Assistant General Secretary (P.O. Box 1497, Cape Town) of any changes in address or additions which may be necessary, as soon as possible.

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South African Association for the Advancement of Science.

Honorary President:
HIS MAJESTY THE KING.

Eleventh Annual Meeting, Lourenco Marques.

(July 7th to 12th, 1913, inclusive).

CIRCULAR No. 3.

The Eleventh Annual Session of the Association will be held at Lourenço Marques from Monday, 7th July, to Saturday, 12th July, 1913, inclusive, under the Presidency of Dr. A. W. Roberts, D.Sc., F.R.A.S., F.R.S.E.

Papers.—Attention is drawn to the general remarks in the previous circulars regarding papers and contributions proposed to be read before the various Sections.

The following papers have already been promised:—

SECTION A.—ASTRONOMY, MATHEMATICS, PHYSICS, METEOROLOGY, GEODESY, SURVEYING, ENGINEERING, ARCHITECTURE AND IRRIGATION.

Hon. Secretaries, Prof. J. Orr, B.Sc., M.I.C.E., P.O. Box 1176, Johannesburg (*Recorder*); and J. Vaz Gomes, Electrical Engineer to the Railways, Lourenço Marques.

1. Presidential Address: J. H. von Hafe.

2. "The nebular hypothesis and the constitution of the stars": R. T. A. Innes, F.R.A.S., F.R.S.E.

3. "The geodetic survey of Mozambique": Col. B. da Silva.

4. "A plea for the more exact measurement of rainfall": F. Flowers, F.R.A.S., F.R.G.S.

SECTION B.—CHEMISTRY, GEOLOGY, METALLURGY, MINERALOGY and GEOGRAPHY.

Hon. Secretaries, Prof. G. H. Stanley, A.R.S.M., F.I.C., P.O. Box 1176, Johannesburg (*Recorder*); and Staff-Captain Alberto Graça, Military Headquarters, Lourenço Marques.

1. Presidential Address: Prof. R. B. Young, M.A., D.Sc.

2. "The bearing of recent discoveries of early Tertiary shells near Trinidad and in Brazil on hypothetical land routes between South America and South Africa": Miss Carlotta J. Maury, Ph.D.

SECTION C.—BACTERIOLOGY, BOTANY, ZOOLOGY, AGRICULTURE, FORESTRY, PHYSIOLOGY, HYGIENE AND SANITARY SCIENCE.

Hon. Secretaries, Frank Flowers, F.R.A.S., F.R.G.S., P.O. Box 1878, Johannesburg (*Recorder*); and Lieutenant J. B. Botelho, Chief Veterinary Officer, Lourenço Marques.

1. Presidential Address: A. L. M. Bonn, C.E.

2. "Town sanitation and treatment of sewage": W. J. Davenport.

3. "The relation of sewage flow to water supply": W. J. Davenport

4. "The sanitary state of the stock of the Lourenço Marques district": Lieut. Botelho.

5. "Notes on the distribution and character of reptiles and amphibians in South Africa": J. Hewitt, B.A.

6. "A nematode worm in the tomato": Prof. H. A. Wager.

7. "Evolution of trees": Prof. H. A. Wager.

SECTION D.—ANTHROPOLOGY, ETHNOLOGY, EDUCATION, HISTORY, MENTAL SCIENCE, PHILOLOGY, POLITICAL ECONOMY, SOCIOLOGY AND STATISTICS.

Hon. Secretaries, Howard Pim, P.O. Box 1331, Johannesburg (*Recorder*); and Juvenal Elvas, Posts and Telegraphs Department, Lourenço Marques.

1. Presidential Address: J. A. Foote, F.G.S.

2. "The phallus cult among the Bantu": Rev. J. A. Winter.

3. "The condition of the natives of Delagoa Bay in the 16th century, according to early Portuguese documents": Rev. H. A. Junod.

Communications regarding papers intended to be read may be addressed to one or other of the Secretaries of the Sections concerned, or to the General Secretaries of the Association.

General Secretaries, Dr. C. F. Juritz, M.A., F.I.C., P.O. Box 1497, Cape Town; and H. E. Wood, M.Sc., F.R.Met.S., Union Observatory, Johannesburg.

Assistant General Secretary, H. Tucker, P.O. Box 1497, Cape Town (Telegraphic Address, "Scientific," Cape Town).

Popular Lecture. An evening discourse, entitled "The History of Portuguese conquest and discovery," illustrated by lantern slides, will be delivered by Mr. S. Seruya, at 8 p.m., on Friday, 11th July, in the Town Hall.

Accommodation.—The Reception Committee is arranging special terms with the various hotels, and the following list of hotels is furnished, members being recommended to communicate their intentions at an early date:—

Cardoza Hotel, 15s. per diem.	
International Hotel	8s. to 12s. 6d. per diem.
Polona Beach Hotel	8s. to 12s. 6d. per diem.
Grand Hotel	8s. to 12s. 6d. per diem.
Central Hotel	8s. to 12s. 6d. per diem.
Savoy Hotel	8s. to 12s. 6d. per diem.
Old Club, Private Hotel	8s. to 12s. 6d. per diem.

The average price of full accommodation may be taken as 12s. 6d. per diem. A proposal is under consideration to use a new school as a residential club for gentlemen visitors only, at an inclusive charge for board and lodging at 12s. 6d. per diem. This would only be undertaken if justified by the numbers of intending visitors. Additional accommodation, exclusive of board, will be provided in some public building at a nominal rate of 3s. to 5s. per diem. Members desiring further details are recommended to apply *direct to* the General Secretary, Union Observatory, Johannesburg.

Concession Tickets.—It is notified for general information that it will be necessary for the wives or other relatives of members, who may wish to avail themselves of the privileges of concession fares, to join the Association, *not* as Associates at 15s. (a form of membership for the session reserved entirely for persons resident in the centre where the meetings are to be held), but as ordinary members at 20s. (no entrance fee being payable).

Reception Room.—Members should, as soon as possible after arrival at Lourenço Marques, inscribe their names and addresses in the Members' Register. The Reception and Information Bureau will be open for this purpose in the Government Pavilion.

Townshend, Taylor and Snashall, Printers, Cape Town.

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THE

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The price of this Journal to the General Public is two shillings per copy. Every member of the Association is supplied with one copy free, and may obtain extra copies at one shilling per copy. Applications for copies should be addressed to the Assistant General Secretary, P.O. Box 1497, Cape Town.

The monthly numbers of the Journal are bound in such a manner as to permit of the whole volume being bound together, at the close of the year, in a style uniform with that of the Annual Reports previously issued by the Association.

CORRESPONDENCE.—All communications other than those relating to the Journal *should be addressed to the Assistant Secretary, P.O. Box 1497, Cape Town.* (Telegraphic address: "*Scientific,*" Cape Town.)

Communications for the Editor may also be addressed to P.O. Box No. 1497, Cape Town.

SUBSCRIPTIONS.—Subscriptions of £1 for the year ending 30th June, 1914, are now due.—Members are requested to be so kind as to remit the amount as soon as possible to the Assistant General Secretary, P.O. Box 1497, Cape Town. Unless such members pay the amount due at an early date, great inconvenience and probably unnecessary expense will be caused, as it is very difficult to determine what number of copies of the Journal will be required. The Council therefore appeals to every member for support and co-operation, and asks that outstanding subscriptions be paid without delay. THE JOURNAL WILL BE SENT ONLY TO THOSE WHOSE ARREAR SUBSCRIPTIONS ARE PAID.

Cheques, etc., should be crossed and made payable to THE ASSOCIATION, *not to the Secretaries* or *Treasurer individually.* 6d. should be added to country cheques for exchange.

C.G.H. Savings Bank Buildings,
St. George's Street,
Cape Town, 1st July, 1913.

PROCEEDINGS OF THE ASSOCIATION.

Copies of the following volumes (Royal 8vo.) of the Association's Reports may be obtained from the Assistant General Secretary (P.O. Box 1497, Cape Town) at the prices set against them:

Vol. I.—Cape Town, 1903. 556 pp. Price, 10s. net; to Members, 5s.
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One shilling should be added to the cost of each of the above volumes for postage.

The Association has also on hand a few copies of the Report of the Meeting of the British Association in South Africa in 1905; price 24s.; to members, 10s. 6d.

"SCIENCE IN SOUTH AFRICA."—A few copies of this valuable handbook, which was specially prepared for the Members of the British Association visiting South Africa in 1905, are for sale, price 21s. (or 22s., post free).

INFORMATION REGARDING THE ASSOCIATION.

OBJECTS.—The objects of the Association are:—To give a stronger impulse and a more systematic direction to scientific enquiry; to promote the intercourse of Societies and individuals interested in Science in different parts of South Africa; to obtain a more general attention to the objects of pure and applied Science, and the removal of any disadvantages of a public kind which may impede its progress.

LIFE MEMBERS.—Life Members shall be eligible for all offices of the Association, and shall receive gratuitously all ordinary publications issued by the Association. Every Life Member shall pay, on admission as such, the sum of Ten Pounds. An Ordinary Member may at any time become a Life Member by one payment of Ten Pounds in lieu of future Annual Subscriptions.

ORDINARY MEMBERS.—Ordinary Members shall be eligible for all offices of the Association, and shall receive *gratuitously* all ordinary publications issued by the Association during the year of their admission, and during the years in which they continue to pay *without intermission* their Annual Subscription. The Annual Subscription for ordinary members is One Pound, payable first at election and thereafter on the 1st of July of each year.

ASSOCIATES.—Associates are eligible to serve on the Reception Committee, but are not eligible to hold any other office, and they are not entitled to receive gratuitously the publications of the Association. The Subscription for Associates for a Session is Fifteen Shillings.

LADIES.—Ladies may become Members or Associates of the Association.

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