THE PROCEEDINGS OF THE ROYAL SOCIETY OF QUEENSLAND.

1885.

VOLUME II.

Brisbane:
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JUNE, 1886.

RULES.

Title and Scope.

I.—"THE ROYAL SOCIETY OF QUEENSLAND," is formed for the furtherance of natural and applied science, more especially by means of original research.

Membership.

II.—The Society shall consist of Members and Corresponding Members.

1. Members shall be those who have been admitted to the Society after having been proposed and seconded at an ordinary meeting, and elected by ballot at the next ordinary meeting; provided that no rights of membership shall accrue until the subscription and entrance fees shall have been paid.

2. Corresponding Members shall be those who, not being resident in Queensland, shall from time to time communicate valuable information, and shall have been elected by ballot at an ordinary meeting on the nomination of the Council.

Rights of Members.

III.—1. Members shall be entitled to be present and vote at all meetings of the Society; shall receive post-free all its publications; and generally participate in its benefits.

2. Corresponding Members shall have the same rights except that of voting.

Subscription and Entrance Fee.

IV.—1. The annual subscription shall be one guinea, payable on or before the 1st of January. Any Member who, after notification by the Treasurer that his subscription is due, shall have failed to pay it before the 1st of April, shall be held to have retired from the Society, but may be re-instated during the current year by the Council on payment of his subscription for the year.

2. Members may at any time commute the annual subscription by payment of ten guineas.

3. Each Member shall pay an entrance fee of one guinea.

Patron.

V.—The Governor of Queensland shall (subject to his consent) be Patron of the Society.

Officers.

VI.—The officers of the Society shall be a President, a Vice-President, a Treasurer, and an Honorary Secretary.

Council.

VII.—The officers, together with five non-official members of the Society, shall constitute the Council.

Election of Officers and Council.

VIII.—The Officers and Council of the Society shall, after nomination, be elected by ballot at the Annual Meeting, provided that the President and Vice-President shall not be eligible for office for two years in succession.

Nominations for the Council and Officers, signed by a Member, and accompanied by the nominee's written consent to serve, shall be delivered to the Secretary not less than one week before the date of the Annnal Meeting.

If the nominations and vacancies to be filled up are equal in number, the person or persons nominated shall thereupon be declared by the Chairman of the Meeting to be duly elected; but if the nominations exceed in number the vacancies to be filled, the election shall be decided by ballot.

Each member present, having been furnished with a list of the several nominations shall vote by striking out the names of those for whom he does not intend to vote.

Duties of Officers and Council.

IX.—Treasurer.—The duties of the Treasurer shall be to receive, and, with the sanction of the Council, disburse all moneys on account of the Society; and at the annual meeting following his term of office, submit a balance-sheet, audited as is hereinafter provided.

Honorary Secretary.—It shall be the duty of the Honorary Secretary to perform the clerical work of the Society, including the receipt of moneys and their transference to the Treasurer.

Council.—The duties of the Council shall be to supervise the correspondence, receipts, and expenditure; to select papers and communications to be read at the meetings, and cause, in their discretion, the same to be printed; to order the time and place of meetings; and generally to act in the interests of the Society.

Council Meeting.

X.—The Council shall meet at least once every month. Any member of the Council absent without leave from three consecutive meetings shall thereby forfeit his seat.

Vacancies in Council.

XI.—In case of a vacancy occurring by the death, resignation, or other cause, of any member of the Council, the remaining members may appoint another member of the Society to fill such vacancy.

Ordinary Meetings.

XII.—An Ordinary Meeting shall be held each month at such time and place as the Council may appoint. The order of business shall be as follows:—

The minutes of the last meeting shall be read.

Candidates for admission to membership shall be proposed, and those proposed at the preceding meeting shall be balloted for.

Donations, exchanges, and purchases shall be reported.

Communications in writing shall be read; and may be discussed within limits set by the chairman.

Specimens, models, drawings, &c., may be exhibited, examined, and explained.

Visitors.

XIII.—Each member present at the Annual or at an Ordinary Meeting may introduce one visitor, who, on the invitation of the chairman, may take part in the scientific proceedings of the meeting.

Special Meeting.

XIV.—A Special Meeting may be called at any time by the Council at their own instance, or on the receipt of a requisition in writing, setting forth in full the object of such meeting, signed by not fewer than five members.

Fourteen days' notice shall be given of the date and object of a Special Meeting; and such meeting, if summoned in accordance with a requisition, shall be held within one month of the date of the receipt thereof.

Annual Meeting.

XV.—The Annual Meeting shall be held in July of each year. The objects of the meeting shall be to receive the Annual Report of the Council; to elect the Officers and Council; and to appoint an Auditor of the Accounts for the ensuing year.

Quorum.

XVI.—At any Ordinary Meeting or meeting of the Council three members shall form a quorum.

At the Annual and at Special Meetings the quorum shall be ten.

By-Laws.

XVII.—The Council shall be empowered to make such by-laws as may be necessary for the management of the Society; but such by-laws shall not be binding until ratified by a Special Meeting.

Property.

XVIII.—All property whatsoever belonging to the Society shall be vested in three Trustees in trust for the use of the Society; but the Council shall control the disbursements of the funds and management of the property of the Society.

Vacancy—Trustees.

XIX.—In the event of a vacancy occurring in the number of Trustees, it shall be filled up at the next Annual or Special Meeting of the Society following such vacancy.

Sections.

XX.—The Council shall have power to establish Sections or Committees for the furtherance of original research.

Change of Rules.

XXI.—No change in the Rules of the Society shall be made, except by a resolution carried at a Special Meeting held for that purpose, notice of which meeting shall have been given as required by Rule XIV.

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HIS EXCELLENCY SIR ANTHONY MUSGRAVE, K.C.M.G.

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Müller Sir Ferdinand von, K.C.M.G., M.D. & Ph.D., F.R.S., &c.

CONTENTS.

PAPERS—

NOTES—

PLATES.

PROCEEDINGS

OF THE

Royal Society of Queensland.

THE Monthly Meeting of the Society was held on Friday, 9th January. The Vice-President, C. W. De Vis, Esq., M.A., in the Chair.

The following New Members were elected:—J. Bell, Esq., Brisbane; W. H. Parish, Esq., Springsure.

The Chairman announced that a Petition of the Members, signed on their behalf by the President, had been forwarded to His Excellency Sir Anthony Musgrave, praying His Excellency to take such steps as were necessary to secure to the Society the proper sanction for the title which it had assumed, and that a reply had been received wherein it was stated that His Excellency had much pleasure in moving the Secretary of State for the Colonies to obtain the necessary permission.

DONATIONS ANNOUNCED.

"Geological Surveys in New South Wales." *Parliamentary Papers, N.S.W.*, 1853-55. From A.W. Jardine, Esq., Rockhampton.

"Report of the General Meeting of the Paisley Philosophical Institution." Paisley, 1883. From J. Bell, Esq.

"The Midland Medical Miscellany." Vol. III., No. 35, 1884. From the Editor, Leicester.

"Transactions of the Norfolk and Norwich Naturalists' Society, 1883-4, Vol. III., Part 5. Norwich, 1884. From the Society.

"The Australian Irrigationist," No. 5. Melbourne, 1884. From the Editor.

"Russkago Geographicheskago Obshtchestva." Transactions, Vol. XX., Part 3. St. Petersburg, 1884. From the Imperial Geographical Society.

The following Paper was read:—

NOTES ON THE PHILOLOGY OF THE ISLANDS ADJACENT TO THE SOUTH EASTERN EXTREMITY OF NEW GUINEA,

BY

WILLIAM E. ARMIT, F.L.S.

During my recent exploring trip to the Louisiade Archipelago and the Islands adjacent to New Guinea, discovered by Captain, now Admiral, Moresby in 1870-2, my attention was directed to the different languages spoken by the inhabitants of the groups and single islands I visited, with a view to tracing their affinity to each other and to the languages spoken in New Guinea on the one hand, and in the Islands of the Western Pacific on the other.

I thought that, perhaps, a knowledge of these languages, or dialects, would prove useful in determining whether the present inhabitants were truly indigenous, or, as I was inclined to believe, an admixture of foreign blood had taken place at some time more or less remote by immigration from the East or West. I therefore obtained vocabularies of every tribal language which came under my observation, but I deeply regret that these were lost at Moresby Island during my illness. I have now only a few words of the Moresby Island, Teste Island, and Bute Island dialects, which I submit to the Society merely as an earnest of future and more complete contributions.

Commencing at Dinner Island (Samarang), we have a language which is spoken by the people of Hayter Island (Sariba), Blanchard Island (Dou-ïn), Heath Island (Loggé-a), the Dumoulin Islands, and Teste, Bentley, and Kitai Islands.

The last named Island lies within a couple of miles of the eastern extremity of Moresby Island, yet the language is distinct from that spoken on the latter The inhabitants of Milne Bay (Maiwarra and Wagga-Wagga), speak the same language as those of Moresby Island (Basilac), although Hayter and Basilisk Island intervene, while those of the last named have an entirely distinct dialect, differing from any of those in use around them, although their Island which they call Adea or Sidea, is wedged in tightly between Hayter and Moresby Islands, whose inhabitants, as I have pointed out, speak different languages.

The people of Normanby, Lydia, and Ferguson Islands, all have their own dialects, in fact, on the first named, I was informed that there were several distinct tribes and hence also dialects. This distribution of language is very remarkable. It will be seen more plainly by glancing at a chart of the region under consideration.

Dinner, Blanchard, Heath, and Hayter Islands form a cluster. The Dumoulin Islands lie twenty miles to the S. E., and Teste Island still further east. Bentley Island we find lying east of the extremity of Moresby Island, close to which nestles Kitai, a mere speck on the map. The inhabitants of all these speak one tongue. Those of Moresby Island use a dialect spoken on the mainland of New Guinea, and may be an offshoot of the Maiwarra tribe.

I cannot understand the origin of the dialect of the Basilisk Islanders, who differ very widely from their neighbours, being warlike and aggressive. They are also physically finer men, and know it. This perhaps has exerted a tendency to keep them isolated from the surrounding tribes, with whom, prior to the advent of missionaries, they were constantly at war.

Normanby, Lydia, and Ferguson Islands, owe their distinct dialectic forms to their distance from the mainland. But although the language of the Dinner Island or Samarang Group is spoken on so many separate islands, it must be borne in mind that the people of these are distinct tribes, with the exception of those living on Bentley and Kitai Islands, who are offshoots of the Teste or Waré tribe.

Now going to the Engineer Group, which is inhabited by people bearing a most unenviable notoriety as cannibals, we find a language made up partly of Teste, Wood-lark, and some other unknown dialect, which may perhaps have been spoken by the original inhabitants of the group.

That we can trace direct immigration here, is, I think, indubitable, especially when we add the fact that these people are the only ones who visit the Wood-lark Islands from which, by the way, the Papaw (C. papaya) was first introduced among these Islands and into New Guinea.

Farther east again, at Bute Island—one of the Redlich Group—a language is used which differs entirely from any of those in use among the Islands we have just considered, and I am inclined to believe that further knowledge on this subject will prove that it originally came from the west. Also, a marked difference exists in these people not practising anthropophagy as we know is the case among the tribes inhabiting the Islands nearer to New Guinea.

Many words are used on different Islands belonging to the dialect of some other place, but these have invariably been introduced by trading canoes and do not form part of the language in daily use.

For instance, if I wanted a drink of water on Moresby Island, and asked for "waila," its Teste Island equivalent, it would be brought to me, but when speaking together in the Basilac dialect, "goila" would be the word used.

In conclusion, I trust that next year I shall be in a position to forward good vocabularies to the Society from the Islands above mentioned, as also from East Cape (Tawéra), Normanby Island (Duan), South Cape (Su-au), and other localities on the northern coast line of New Guinea.

List of words used at Moresby Island (Basilac) with English equivalents:—

Man	tau.
Woman...	waina.
Infant	méru-méru.
Boy	boi-oi.
Daughter	natuna.
Mother	shinnana.
Father	tamuna.

(Phrase: Wénissé tamuna—the father of Wénissé.)

Woman (married)	wainenni.
Chief	tau-bada.
Title of rank "Governor"	gogan.
Eyes	mamphon.
Genitals (male)	capasuan.
„ (female)	vaba.
Comb	suari.

(The same word being used to designate Orion's Belt, that constellation being suggestive of the native comb.)

Beads	bullu-dim-dim.
Shirt, calico, blanket	guama.
Sleeping-mat	capatilli.
House	numa.
Thatch	ga-toi.
Garden	gana.
Fibre (of Pandanus)	emo.

Bag	who-otu.
Earthenware boiler	nahu.
Spoon (of cocoanut-shell)	ké-a-ka.
Lime-spoon	ké-né.
Lime	kauli.
Betel-nut	beda.
Yam	quatea.
Yam (a prickly variety)	weda.
Taro	huni.
Taro	hudo.
Cocoanut	niu.
,, (ripe)	matulina.
Sugar-cane	garu.
Pumpkin	sussu-geru.
Sago	rabbia, labbia.

(This equivalent is also in use at Port Moresby amongst the Motu, and at Mount Astrolabe amongst the Coiari native tribes of New Guinea).

Bread fruit (A. incisa)	wakari.
Banana	béhé.
Canoe	wah-ga.
Wooden knee for canoe	géru.
Hatchet	kilam.
Knife	kéd-jé.
Spear	wammari.
Dance	cappa-cappa.
Feast	soë.
One	késéga.
Two	labui.
Three	toro.
Four	esopari.
Five	barigigi.
Ten	sanaulu.
Ten	,, tea.

Twenty ... ... sanaulu lua.
Thirty ... ... ,, todo.
Forty ... ... ,, washi.
Fifty ... ... ,, dimana.

And further repetition for higher numbers.

Noon-day ... ... dablo.
Ebb-tide ... ... damoun.
Flood-tide ... ... na-wah.
To-morrow ... ... bariga.
Day after to-morrow ... ... borau.
Dog ... ... kedewa.
Pig ... ... poro.

(D'Albertis' records *ai-poro,* a pig in the Epa dialect, Hall Sound.)

Paradise-bird (P. raggiana) ... ... shi-ai.
Megapode ... ... i-dagu-dagu.
Fruit pigeon ... ... boitunumu.
Torres Straits pigeon ... ... gabulu.
Black Cockatoo ... ... quah-ma-happé.
White ,, ... wakéké.
Green parrot ... ... kehoi.
Hornbill ... ... binama.
Fowl ... ... ca-calico.
Capsicum ... ... sarah-dim-dim.
Papau ... ... mau-yop.
Croton ... ... babaca.
Cedar ... ... marawé.
Leaf .. .. lugu.
Seed ... ... iumana.
Water (fresh) ... ... goila.
,, (salt) ... ... carita.
Fire ... ... miau.
Rock ... ... gaima.
Pebble ... ... wéku.

Enough	bèshe.
Plenty	bad-bad-wa.
Many, plenty	kaisulu.
Full	em-hi-o-go.
None, no	ni-gé-ri.
Large	lalakina.
Small	kikiuna.
Good	idé-waddé-wah.
Bad	nai-inai.
Like, resembling	béssiéré.
Cranky, going round	yau-yauli.
Come!	kulaum!
What! Eh!	wah!
What is the matter! What	yawai!
Yes!	O! Ou!
Affirmative exclamation	ku-ku!
My dear!	eliam!
Do do!	héh!
I	yau.
Thou	tam.
Me	ta.
You	coa.
This	bainéné.
That	baitété.
I go (me go)	talobi.
I go	ta-rau.
I arrive	sish-haim.
You arrive	sush-haim.
To walk	ï-ona-pigai.
To remain	mia-mia.
I sit down	ta-sassai.
You sit down	ou-sassai.
I bring	ta-tauli.
To look	gitaí.

I look, to see	Ia gitai, yau-gitai.
You (plural) see	ou gitaí.
To sing	gahru.
To speak, talk	kina.
To eat	taimam.
To sleep	kénoe-kénoe.
To call out, cry	e-tu-tô.
To make, do, bring, fetch	caraia.

Used at Port Moresby and generally wherever I have visited.

To steal	ïlai.
To laugh, smile	i-marai.
To micturate	cassulu.
To defæcate	bushé bushé.
That is all	nabishto.
Deceiving	mahcotah.
Dead	boita.
Ill	i-boita.

[ADAPTATIONS.]

Tobacco...	tobac-ca.
Pipe (smoke)	semokea.
Matches...	manchisa.
Captain	capiná.
"	koapina.
Firearm (man-of-war)	man-woh.
Dog	bow-wa.

NAMES OF MEN.

Tébarié, Gamali-eliam, Marawina.

Salupai, Wammari, Dauléwarréwa.

NAMES OF WOMEN.

Garuwai, Gubai, Nibau, Wénissé.

NAMES OF VILLAGES.

Batu-batui.

Cabai-a-wai-a-wai.

Cua-cu-wé-wé.
Kébu-kébu-na-wa-on.
Manu-a-na-ga.
Modewa.
Samama.
Sé-co-co-wa.
Sirika.
U-bow-na.
U-hura.
Waru-toda-wana.

ISLANDS.

Basilac	Moresby Island.	
Bu yari...	O'Neill Island.	
Poporai	Margaret Island.	
Maré	Rocky Islet, Hoop Iron Bay.	
Adéa or Sidéa...	Basilisk Island.	
Sariba	Hayter Island.	
Samarang	Dinner Island.	
Loggéa	Heath Island.	
Du-ïn	Blanchard Island.	
Anagoussa	Bentley Island.	
Waré	Teste Island.	In Louisiade Archipelago.
Mullallé	Stuers Island.	In Louisiade Archipelago.
Panamau	Imbert Island.	In Louisiade Archipelago.
Malagili	Onessant Island.	In Louisiade Archipelago.
Cappacore ... ... / Nabainolan	Kossman Island.	In Louisiade Archipelago.
Nabaina	Sandbank.	In Louisiade Archipelago.
Silia-Natuna	10 miles east of Kossman Island.	In Louisiade Archipelago.
Punuan...	Dupérré Island.	In Louisiade Archipelago.
Panéatt	Bute Island.	In Louisiade Archipelago.
Missima	St. Aignau.	In Louisiade Archipelago.
Quonatai	Sud Est Island.	In Louisiade Archipelago.

Calaiwa	...	Watt Is.	Engineer Group.
Coiaria	...	Skelton Is.	Engineer Group.
Bari-barigai	...	Butchardt Is.	Engineer Group.
Duau	...		Normanby Island.
Mulua or Murua	...		Woodlark Islands.

MAINLAND, NEW GUINEA.

Suau ...	South Cape.
Maiwarra ...	Milne Bay.
Wagga-Wagga ...	Milne Bay.
Tawéra ...	East Cape.

The following words used at Bute Island, Redlich Group, Louisiade Archipelago, may be useful for comparative purposes· A very brief sojourn on the Island, and the demands made on my time by other researches hindered my further investigations in this direction:—

Bute Island ...	Paneatt.
Betel nut ...	gau-ïra.
Pepper leaf ...	muka.
Lime gourd ...	aru.
Lime spoon ...	dabaiára.
Lime ...	kari.
Comb ...	huari.
Nose ornament ...	emagin.
Hawksbill turtle ...	gonoma.
Armlet ...	nagewan.
Plaited bag ...	bapa.
Water (fresh) ...	wawé.

Amongst the Objects Exhibited were:—

1. Some minute *Acari* by Dr. Bancroft who remarked that he had traced the gangrenous growth affecting grapes known as "black spot" to the injury inflicted by a small acarus. These

insects were found usually close to the bud on the young leaves, on the under surface of which their scarlet eggs were deposited. A remedy would probably be found in the usual insecticides, and one of these, tobacco powder, seemed especially to recommend itself. Dr. Bancroft promised to make the disease, which was still under investigation, the subject of a future communication.

2. An example of the Ray, *Rhinoptera javanica, M. & H.*, from Moreton Bay, concerning which Mr. De Vis remarked, that it appeared to be new to the Australian fauna.

3. A nest of the Satin Bower Bird. *Ptilonorhynchus holosericeus*, Kuhl., containing three young birds. This had been procured by Mr. Kendal Broadbent at Maryland near Stanthorpe.

FRIDAY, FEBRUARY 13TH, 1885.

THE PRESIDENT, J. BANCROFT, ESQ., M.D., IN THE CHAIR.

DONATIONS ANNOUNCED.

"Second Annual Report of the Chief Executive Viticultural Officer to the Board of State Viticultural Commissioners," for the years 1882-3, and 1883-4. Sacramento, 1884. From L. A. Bernays, Esq., F.L.S., Etc.

"Reports of the Superintendent of Woods and Forests," 1880, 1881, 1882, 1883. Capetown, 1881-4. From L. A. Bernays, Esq., F.L.S., Etc.

"Reports of the Colonial Veterinary Surgeon," 1880, 1881, 1882, 1883. Capetown, 1881-4. From L. A. Bernays, Esq., F.L.S., Etc.

"Journal of Conchology," Vol. IV., No. 8, October, 1884. From the Conchological Society of Great Britain.

"Victorian Naturalist," Vol. I., Nos. 12, 13. Melbourne, 1884. From the Field Naturalist's Club of Victoria.

"The Midland Medical Miscellany," Vol. III., No. 36, December, 1884. From the Editor, Leeds.

"Russkago Geographicheskago Obshtchestva" Transactions, Vol. XX., Part 5, St. Petersburg, 1884. From the Imperial Geographical Society.

The following Papers were read:—

THE ECONOMIC ASPECTS OF ENTOMOLOGY.

BY

L. A. BERNAYS, ESQ., F.L.S., ETC.

I DESIRE to be permitted to offer a few brief remarks upon a subject of large importance to the cultivators of the soil in Queensland, but one which hitherto has received little or no attention. I refer to what may be called "Industrial or Economic Entomology," that is, a knowledge not only of the science, but of the life history and the habits of insects injurious or beneficial—more especially those which prejudicially affect trees and plants which are the bases of staple commodities—and of the remedies against their attacks.

The word "Entomology" conveys to the majority of our farmers and gardeners little other idea than that it is the name of a science, and one with which they have no concern. It is supposed to indicate the study of the names and species of butterflies, beetles, moths, &c., and that its principal outcome is to be seen in the prettily-arranged cases of insects which are shown in museums; but they fail to grasp the idea that the products of their industry are much concerned in the matter. This is largely owing to the fact that so many entomologists confine their labour to diagnosing genera and species, and arranging specimens; and wholly omit from their studies the habits of the creatures, or their influences upon industrial pursuits.

Setting on one side the insects which are instrumental in injuring the flower-garden, and marring the work of the most skilful æsthetic gardeners, there are a vast number of others which arrest or prevent the growth of timber and shade trees, injure our fruit crops, lessen the productiveness of or absolutely destroy field-crops, such as cotton, indigo, turnips, potatoes, liquorice, tea, coffee, chicory, the vine, the cocoanut palm, and other cultural industries upon which depend the prosperity of entire communities. In saying this, I merely state what is but too well known to all who are engaged in the cultivation of the soil; but when I add that in other parts of the world there are known and are applied remedies which are either wholly or partially successful, I state what is known to but comparatively few of the many concerned. The attacks of insects are largely influenced by conditions of season, quantity and periods of rain, combination of rain, and heat or cold, and other climatic phases. We cultivate the soil, and we sow or plant with industry and intelligence, and if the fates are propitious we reap the products of our industry. The absence of sufficient rain might be largely compensated for by irrigation, and in these directions also we fail to avail of the assistance which nature is prepared to afford by yielding her underground waters to render fruitful the surface of the earth. In this case, the small cultivator is mainly deterred by the costliness of the appliances and want of knowledge how to utilize them; but as regards insect enemies, he seems to be content to remain in ignorance of a vast deal of knowledge that exists upon the subject, and to trust wholly to the chapter of accidents.

There is a great deal of practical literature upon the various phases of economic entomology, which might be collected from among English-speaking communities; and I cannot but think that it would be a transaction worthy of the objects of the "Royal Society of Queensland" if the Council were to address itself to the enrichment of its book-shelves by getting together a library of reference upon this important subject. I have noted with much satisfaction that, in our transactions hitherto, a good deal of the eminently practical has found its way into our records. It is possible that this has arisen from the fact that, in the comparatively small community in which we are commencing our work, there are not sufficient specialists in science to provide material for all the meetings of the Society. But if this circumstance leads us into admitting to an important place in our recorded transactions, papers of a wholly practical, or only partly scientific character, it will, I think, popularise the institution and much enlarge its sphere of usefulness.

Applications made through the Government, or other influential sources which may suggest themselves to the Council, to the authorities of the various British Possessions, would bring together, at little cost, the publications extant upon the insect enemies of many crops which are specialities in different countries, and which can be grown in this colony; while similar influences might procure much which has been written in French and German upon entomology in its application to industrial pursuits.

To the United States of America, however, we must turn for the soundest and most practical information extant in the English language upon the insect enemies of plants and the best remedies against their injurious effects. The enlightenment of the Government of the States has taught them that the welfare of that great country largely depends upon the successful cultivation of the soil; and in no country of the world are agriculture and horticulture more thoroughly systematised or receive better recognition from the State. The importance of the bearing of insect life upon the numerous cultural industries in America is so fully recognised by the Government as to have led, many years ago, to the erection of a State Entomological department, issuing numerous publications. In more than one of the separate States are found similar organizations; and in every case the information promulgated is of a highly practical character, the result of exhaustive scientific investigation, combined with carefully-conducted remedial experiments. But valuable as these institutions are, the American agriculturists are beginning to agitate for the addition of economic entomology to the curriculum of State education. A good illustration of this movement is to be found in the following resolution, passed in November, 1883, by the State of California Fruit-growers Convention:—"Whereas the fruit and vine interests bid fair to become the leading industries of the State,—resolved, 'that we, in convention assembled, as representing the fruit-growers of this State, do urgently and earnestly request, pray, and by right demand, the introduction into our public schools of the study of Economic Entomology.'"

I am sure that some steps in this direction should be taken in Queensland, where the cultivation of the soil and the utilization of its natural grasses involve the leading industries of the colony; but our Government have got to be educated up to the point of thoroughly apprehending the importance of the subject. It will be better, therefore, if in any movement made we commence by "earnestly requesting," and relegate any assertion of a "right to demand" to a future period of our history; when popular requirement has left the track of constructing railways to everywhere and nowhere, of the building of court-houses, and the establishment of town clocks, and when we come to require at the hands of our representative men measures for the more material development of the country's resources in directions which will foster and aid its industries, and thus directly add to the prosperity of the people and to the wealth of the country.

I venture to suggest to the Council of the Society, whether the first attention of the Government to this grave neglect might not, with credit to the Society, be drawn by their body. It is of no use to leave the first movement to be made by those whose industry it is proposed to assist. The cultivators of the soil in Queensland have not yet learned the lesson of co-operation, and of acting in concert for the common good. Our Agricultural Associations have hitherto confined their attention almost entirely to the promotion of shows; while the Planters have combined chiefly on the labor question. Here, again, America affords a notable example, giving abundant instances of the vast amount of information which can be elicited and promulgated by well organized Agricultural and Horticultural Socities.

The subject of Economic Entomology embraces a vast field, beyond the phases which directly affect plant life, as the manufacturers of, and traders in, most animal and vegetable products known to their cost; while the insect friends of mankind present ample scope for the promulgation of knowledge of the methods in which their services are rendered. To all of these the American workers in this interesting field of investigation have given more or less attention, while naturally concentrating most of their effort upon remedial measures against those insects which interfere between the tiller of the soil, and the full harvest of his industry. In that country, also, is better understood the importance of preserving the balance of nature, by observation of the true habits of birds, and of the larger insects, and their share in mitigating or intensifying insect depredation; a subject upon which I fear much ignorance prevails in this part of the world.

There is no field of labor upon which this Society could enter, better calculated to do good in its generation, than that which I so imperfectly venture to bring to your notice to-night; and I am satisfied that a representation upon the subject made to the Minister for Education by the Council of the Society would be listened to with attention and respect, and would perhaps bear practical fruit.

THE SEA SCUM AND ITS NATURE,

BY

HENRY TRYON.

Those who have occasion to reside along our sea-board at this season of the year are unpleasantly aware of the proximity of the sea by reason of an almost overpowering odour suggestive of the presence of something very bad. This odour is found to emanate from a certain greenish-coloured film, of greater or less thickness, which is left on the shore by the receding tide, as also perhaps from patches of a scum-like substance of a brownish-green colour floating on the water, as the matter of this film appears before it becomes stranded. This state of things which has been very marked lately in the Bay and all up the coast—as far as Townsville at least—is no isolated occurrence, but always to be met with to some extent during the prevalence of the strong winds which blow from the ocean, where, too, the same scum will also be observed covering large uninterrupted tracts or smaller areas separated by greater or less intervals of sea unoccupied by it, during many hours of the day. Moreover, it was noted as occurring in Moreton Bay by Mr. J. D. MacDonald, a naval surgeon, nearly thirty years since. [Roy. Soc. Proceedings, Feb. 26, 1857.] Neither is it peculiar to Queensland waters, for prior to Mr. MacDonald's observation the occurrence of similar floating matter was reported off Cape Leeuwin (Darwin—"Journal of Researches, &c.," Ed. 1884, p.14). And more recently Mr. George Francis has entered somewhat fully into the salient features of a 'scum'—apparently identical with the subject of these remarks which he met with in the estuary of the Murray. [*Nature*, 1878; vol. xviii., No. 444, pg. 11.

Beyond the Australian seas this sea sawdust* or whale's spawn, as it has been popularly named, has been observed at numerous localities throughout the Pacific and Atlantic Oceans, sometimes covering interruptedly large areas of several hundred miles in extent.

On closer observation its particular state is very evident, and when slightly magnified it presents a "chopped hay" appearance, and when more so all the characters by which *Trichodesmium*—a genus belonging to a spurious group of minute algæ—has been defined, are very manifest.

The occurrence of this genus in Moreton Bay is on other grounds more than probable, since this very evident odour under the appearances described is shared by the Trichodesmium of authors; and, moreover, although Trichodesmium is not mentioned by Dr. Turner in his "Phycologia Australis," it is recorded by Otto Sonder from north and tropical east Australia. [Algæ Australianæ Hactenus Cognitæ, Hamburg, 1880. *Müller's Fragm. Phyt. Aust. vol. xi., Sup. p. 42.*]

Trichodesmium,† a genus founded by Ehrenberg for a single species T. erythræum, includes those minute algæ of the group Nostocaceæ which are composed of regular microscopic

* M. Evenor Dupont, in allusion to a similar phenomenon in the Red Sea, writes :—" La sciure d' un bois de cette couleur de l'accajou par example produirait à peu près le même effet."—*Comptes Rendus*, 1844; vol. xix., p. 171.

† Montagne gives the following definitions of the genus and species: —" Fila libera membranacea, tranquilla, simplicia, septata, fasciculata, fasciculis discretis, muco obvolutis. Algæ sociales rubro sanguineæ, demum virides, superficiei maris immenso grege innatantes. *Char. Spec. Trichodesmium erythræum*, Ehrenb. Filis libere natantibus membranaceis ancipitibus: in fasciculos minutos fusiformes et muco involutos paralleliter conjunctis, articulis diametro subduplo brevioribus, geniculis æqualibus constrictis aut extantibus."—*Comptes Rendus*, 1844; vol. xix., p. 171.

tubules, with a clear investment, lying parallel, and in juxtaposition in one plane. Each tubule is septate, and the intervals between the septa, or cells, are filled with a fluid coloured by a soluble pigment which also obscures the natural hue of the chlorophyl granules which the cells contain in large quantity.

The Trichodesmium erythræum, *Ehrenb.*, as defined by its author [Pogg. Annalen, 1830. p. 506] in 1830, has been found by Montagne to include two distinct forms which he has named T. Ehrenbergii and T. Hindsii [Ann. des Sciences Nat. 3 Sér. vol. ii., pg. 360, pl. xix., and "Comptes Rendus," 1844, vol. xix., pg. 172] and this interpretation has been followed by Kützing [Species Algarum et Tabulæ Phycologicæ I. pl. 9., fig. 3 and 4].

More recent authors however have not retained these species, and I am of opinion that the differential features stated to be afforded by the width of the filaments and the length of the intervals between successive septa cannot be relied on, as in every example of the Moreton Bay scum examined by me these variants were present. I have not, however, been able to refer to either Montagne's or Kützing's figures of these species, and that given by Berkeley [Introd. to Crypt. Botany, London, 1857, fig. 36,] as representing T. erythræum does not present sufficient details to be of use for comparative purposes.

On keeping a portion of the scum in sea water, decomposition of the nature of fermentation with the evolution of gas sets in after a few hours, and the pigment being discharged from the fluid contents of the cells and from their contained chlorophyl, the scum itself changes from brown to green, and ultimately to a darker colour, meanwhile the filaments become ruptured or not at the septa, by the dissolution of their investing hyaline sheath.

Although I have never heard of such an occurrence in Queensland waters, it is very evident that under certain natural conditions in other quarters—yielded by the degree of the salinity* of the sea or its temperature—this pigment is discharged in a similar manner from the scum into the ocean where it floats, and hence the appearance of those seas of blood which voyagers have long remarked in the Indian Ocean and Red Sea.† In fact Ehrenberg was the first to refer the red colour extending over large tracts of sea in the latter locality (the Bay of Tor) to the alga under consideration, and to which he assigned the name by which it is known at the present day, *i.e.*, Trichodesmium erythræum, and numerous writers have found an origin for the title Red Sea in this remarkable appearance, due as he demonstrated to this particular plant.‡

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* Whatever may be their condition in other localities where the phenomenon of the blood-red sea occurs, and whether or not extra saline waters get the upper hand by means of the ocean currents which occur at these spots, it is well known that the waters of the Red Sea carry an immense amount of salt, far surpassing the average. On referring to the "Contemporary Review," August, 1880, pg. 242, I find that it is stated, on the authority of Mr. Justus Roth, that "Forchhammer estimates the saline constituents of this sea at 43.148 per mille, Robinet and Lefort at 41.814, the water being drawn at Suez prior the opening of the Canal, and that C. Schmidt found in October, 1875, 39.759 per thousand of saline constituents." The writer also refers to the Meteorological Papers of the Board of Trade, which corroborate the accuracy of these conclusions.

† The graphic descriptions of the appearances, as given by M.M. Evernor Dupont in Montagne's Paper [Comptes Rendus, xix., p. 171,] and a writer in the "Colombo Herald" [May 14th, 1844,] also allusions to the narratives of Hinds and Darwin are given by Lindley [Vegetable Kingdom, London, 1853, pg. 16-17.] These and other accounts of the phenomena of the blood-red sea are quoted by MacDonald [Roy. Soc. Proc., Feb. 26, 1857,] and other writers, and references to earlier notices still are given by Buckle ["Posthumous Works," London, 1872 ; vol iii , pg. 150].

‡ The vexed question as to the origin of the term 'Ερυθρη θαλλάσσα red sea) applied by Herodotus [Herodoti Historia, Oxon., 1873, II. 8, 158, 159 ; iv., 39,] to the whole of the Indian Ocean, and by later Greek authors, including the Septuagint translators, to what we, in adopting their designation, have named the Red Sea, cannot be entered upon here ; but it is not without interest, when the Homeric interpretation of colours has been called in question [Gladstone, Nineteenth Century, Oct., 1877,]

That the absence of red seas off the coast here is due to a want of such special conditions, as I have surmised to exist under other climatic circumstances in the Indian Ocean, seems the more probable in view of the fact that the Hoang Hae or Yellow Sea of China, which has a climate not unlike that of the Queensland waters, and where the Trichodesmium also exists, is stated to have received its name from the natural yellow-brown colour which the scum invariably possesses there.

During the decomposition of the scum, when washed ashore, when banked against the windward side of a vessel at anchor, or when confined in any receptacle, a very unpleasant odour is liberated, which has been compared to such odours as are to be found in a category, including those of crushed artichoke, rancid butter, &c. Here and elsewhere the scum as it occurs out at sea seldom, if ever, diffuses this unpleasantness, as was remarked by MacDonald in his description previously cited, and as is to be concluded from the negative evidence of M. Evenor Dupont and Mr. Charles Darwin on the subject. This pungent odour sometimes exerts a decided physiological action on the human subject, causing, according to Mr. Berkeley (quoting the experience of Mr. Hinds who, during the voyage of the "Sulphur," met with this sea scum in 1837 at Liebertad, St. Salvador), inflammation of the conjunctiva and nasal mucous membrane. This happily, however, is not an invariable attendant circumstance. Suspected action of a very virulent nature receives some confirmation from the particulars related by Mr. G. Francis, of Adelaide, in his article in "Nature" [1878, vol. xviii., No.

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to find that the same idea conveyed by the word 'Ερυθρος viz., that of the blood-red colour of wine, such as the attendants of Circe gave Ulysses and his companions on their return from the infernal regions to the wave of the wide-wayed sea [Odyssey, xii., 19,] and which Herodotus uses as above in his Erythraean Sea, entered the minds of modern sailors, who, on witnessing the phenomenon, cried out: "This is indeed the Red Sea (whilst) the boatswain likened it to blood from the shambles." [Salt, "Voyage to Abyssinia, London, 1814, pg. 196.]

444, p. 11,] where, writing of a 'Confera' produced in excessive quantities in the Lakes forming the estuary of the Murray, on the shores of which he states it is blown up as a thick green scum, the crusts so formed passing through the Murray mouth into the ocean, to be afterwards wafted ashore; he goes on to relate that this scum is swallowed by cattle drinking at the edges of the lakes, and that it acts so poisonously on them as to rapidly cause death. The symptoms are stated to be stupor and unconsciousness, falling and remaining quiet, as if asleep, unless touched, when convulsions come on, with head and neck drawn back by rigid spasm which subsides before death. Time: sheep, 1—8 hours; horses, 8—24 hours; dogs, 4 to 5 hours; and pigs, 3 to 4 hours. The pathological appearances, as revealed by p. m. examination, are then given, and a verdict pronounced that the plant is rapidly absorbed into the circulation, acts as a ferment, and causes disorganisation.

Although this alga—so poisonous in its properties—is said to originate in these estuarine lakes, and to be wafted out to sea, and afterwards washed ashore. The alternative supposition that is brought in the first instance from the ocean at flood-tide does not appear to have been entertained. However, the physical properties of the scum, especially the colour and opalesence* (which appear to be simply due to chlorophyl in solution) of solutions derived from it, indicate a near alliance with the *Trichodesmium* of Moreton Bay, and certainly point to one of

* The isolated occurrence of one or other of the properties presented by Trichodesmium, and under similar conditions, may refer the phenomenon to animal or plant life floating or suspended in the water, and not necessarily to Trichodesmium itself. Notices of such appearances are to be found in various books of travel, and have been given by Peron, as is pointed out by Darwin, who also adds somewhat to the bibliography of the subject. ("Voyage of the Beaglé," Ed. 1884, p. 16, *note*). For a complete account of the circumstances attendant on the undoubted presence of Trichodesmium, however, and in cases where its presence has been experimentally demonstrated, the reader is referred to the graphic narrative of Darwin himself and to those of Ehrenberg and Dupont.

the Nostocaceæ, although Mr. Francis is of opinion that the Alga may be referred, on what grounds I know not, to Nodularia spumigera, an ally of Protococcus.

Not long since, cattle on St. Helena, Moreton Bay, were observed to be dying from the effects of some poison in a mysterious manner, and Mr. F. M. Bailey, the Colonial Botanist, on an examination of the vegetation of the island, has been, I believe, unable to assign a cause for this state of things. After reading these observations of Mr. Francis, I can scarcely avoid the conjecture that the sea scum of the Bay which has indicated its presence by disseminating perfumes, other than those of Arabie, may also be in some way responsible for these incursions into the St. Helena herd.

FRIDAY, MARCH 13, 1885.

THE VICE-PRESIDENT, C. W. DE VIS, ESQ., M.A., IN THE CHAIR.

NEW MEMBERS ELECTED.

J. H. Daniells, Esq., Government Engineer of Bridges, Brisbane; and A. J. Turner, Esq., Brisbane.

DONATIONS ANNOUNCED.

"Verhandlungen des naturhistorischen Vereines der preussischen Rheinlande und Westfalens." Vol. XXXIX. 2, and Vol. XL., 1, 2. Bonn, 1882-3. From the Naturhistorischen Vereines, Bonn.

"Proceedings of the Linnean Society of New South Wales," Vol. IX., Part 4. Sydney, March, 1885. From the Linnean Society of New South Wales.

"The Australian Irrigationist," No. 6, 7. Melbourne, 1885 From the Editor, Melbourne.

"The Midland Medical Miscellany," Vol. IV., No. 38, 1885. From the Editor, Leicester.

The following papers were read:—

ON BONES AND TEETH OF A LARGE EXTINCT LIZARD.

BY

C. W. DE VIS, M.A.

(PLATES I.-III.)

SIR RICHARD OWEN has lately (Phil. Trans., pt. 1, 1884) adduced evidence, derived from "pleistocene" deposits, of the former existence in Australia of a large pleurodont lizard. In a fragment of a jaw with roots of teeth, submitted to him by the Department of Mines, New South Wales, there were found reasons for concluding that it had belonged, not to a crocodile as at first surmised, but to a lizard allied to Hydrosaurus, but more than twice its size. To the reptile represented by this interesting relic the name Notiosaurus dentatus was assigned by the veteran anatomist, and, in our conceptions of the later bygone scenes of Australian land-life, it pairs off remarkably well with the huge Megalania made known to us by the same author. Under a misapprehension of the stratigraphical horizon of Notiosaurus, arising from the fact that it was merely stated to be "pleistocene," the writer was induced to believe that the lacertilian remains to which his subsequent observations refer were of an age anterior to that of the New South Wales specimen and to propose for them a distinctive name. On reference, however, to Sir R. Owen's original memoir it appears that the jaw described by him was drawn from deposits abounding in Diprotodont and other remains which the writer has been accustomed to regard as, in Queensland, newer pliocene, not strictly pleistocene. Thus corrected, he has no other sufficient reason to doubt that the teeth, and consequently the other bones to be referred to the same lizard, are those of Notiosaurus dentatus, Owen., and under that name, proceeds to describe them. The first, in order of discovery, which at one time appeared to him to belong to an undescribed genus, is a bone of the fore limb—a left humerus in perfect preservation as far as the interval between the radial tuberosity and the head, which is unfortunately lost. Before examining the proofs yielded by this fossil that Notiosaurus was congeneric with the existing Varans of Australia, Monitor, Hydrosaurus and Odatria, and yet was not generically identical with either of them, it may be well to facilitate comparison by tabulating the measurements of this fossil with those of a species of each recent genus:—

	Notiosaurus dentatus. c.m.	Monitor gouldi. c.m.	Hydrosaurus giganteus. c.m.	Odatria punctata. c.m.
Entire length ...	*20 (estimated)	5·0	7·0	1·7
Length to summit of radial tuberosity	17·0	4·0	5·8	1·55
Breadth of distal end...	10·7	2·0	2·5	0·6
Breadth of articulating surfaces	7·2	1·1	1·7	0.325
Least breadth of shaft, palmar aspect	3·2	0·65	0·8	0·125
Thickness of distal end	5·0	0·6	0·95	0·2

* Eight inches.

The length of the specimen of M. gouldi, of which the humerus was measured, was 34 inches; that of H. giganteus 58 inches, and that of O. punctata 17 inches. From the figures tabulated it appears that in the extinct lizard the arm was considerably shorter, in proportion to its breadth, than in the living species. The vastly greater area of the articulating surfaces of the elbow-joint is especially remarkable; not only is it much longer from back to front, by reason of the greater thickness of the bone in this region, but it occupies a larger proportion of the whole breadth. This points to a more robust fore-arm and paw and through them to some variation or restriction of habit. We are further led to observe that the least departure from the proportions of the fossil humerus is made by that of M. gouldi among the living species compared with it.

On the palmar or hinder aspect of the bone, the eye notes at once the unusually deep depression of the olecranal fossa (Pl. 1, o.f.), its depth being apparently exaggerated by the turgescence of the rotulo-condylar region (Pl. 1, r.c.)—the large medullary foramen (Pl. 1, m.f.) is situated on its outer edge, not at its apex as in living genera. The supinator ridge (Pl. 1, s.r.) is strongly developed and, proximad, terminates in an oval tuberosity, 1·75 c.m. in length, for the attachment of the supinating muscle, which must have been of large volume and, therefore, much used in the motions of the fore-limb. Immediately below the tuberosity the ridge is, as usual in this group, perforated by a tunnel for the passage of the great ulnar artery and nerve. In recent forms the perforation is much nearer the end of the ectepicondyle (Pl. 1, e.c.t.) This latter region is almost engrossed by an irregular depression for the origin of the extensor carpi radialis and differs but little in shape from that of Hydrosaurus. On the entepicondylar surface (Pl. 1, ent.) the insertion of the coracobrachialis is into an elongated prominence placed more proximad than the rounder prominence in Monitor and contrasting with the depression for the same muscular insertion in Hydrosaurus. The radial condyle (Pl.. 1, r.c.) is narrower and lower, relative to the ulnar, than in either of the existing genera; the ulnar (Pl. 1, u.c.) condyle broader, less convex than in Hydrosaurus and much less so than in Monitor and Odatria; its inner limit is conspicuously defined by a raised lip continued from the dorsal aspect to the olecranal pit, and forming a groove between its inner side and the entepicondyle—this lip is not developed in the living genera. The proximal edge of the articulating surfaces of the joint on this aspect is nearly parallel with their distal edge—in Hydrosaurus and Odatria it slopes rapidly from the radial condyle inward; in Monitor there is more approximation to its direction in the fossil.

On the dorsal side the surface of the distal expansion is strongly convex—above the middle of the mesial line of the shaft is the broad shallow pit for the powerful tendon of the latissimus dorsi (Pl. 2, l.d.) and on the inner side of it and below it a low ridge passes down, curving outwards in its course to reach the mesial line. The anterior (outer) edge of the shaft ascends with a strong concave sweep to the deltoid insertion (Pl. 2, del.), which stands out prominently: and the contour of this side of the bone clearly indicates an expansion of the proximal in just proportion to that of the distal end.

On separating from the foregoing statement of the superficial characters of the fossil those from which its nearest affinities may be deduced it is not easy to derive a definite opinion from them alone—the relations of Notiosaurus seem to librate equally between Hydrosaurus and Monitor; but when we take into account the comparative dilatation of the bone in Monitor this of surviving genera appears to have diverged the least from its predecessor.

Left scapula.—(Plate III.)

In the Australian genera of the Monitor group of lizards, the scapulas vary less among themselves than do the arm-bones. There is, therefore, an antecedent probability that the shoulder-blade of any extinct member of the family would present fewer salient points of differentiation than the humerus. This consideration leads the writer to believe that a portion of a scapula which he had long ascribed to Hydrosaurus might well belong to the same pleurodont as the arm-bone which has been under notice; but, had this comparative sameness not been observed, it must be confessed that the differences from the Hydrosaurus or Odatria scapula exhibited by the present subject might have continued to be supposed within the limits of individual variation, notwithstanding immense superiority in size. The fossil consists of the articular portion of the scapula proper and that of the coracoid. The scapula neck is broad, and on its outer surface rather concave, resembling in the former respect that of Hydrosaurus; in the latter, neither of the living forms. The hinder wall of the glenoid cavity (Pl. III., gl.) has a downward extension which furnishes a proportionately larger surface of articulation with the head of the humerus. The small foramen at the base of the epicoracoid fenestra (Pl. III., e.f.) is round : in all other respects it has a close resemblance to the scapula of Hydrosaurus. The long diameter of the glenoid cavity is 4·5 c.m., its short diameter 3·8 c.m., the corresponding measurements in Hydrosaurus being 1·2 c.m. and 1·0 c.m. From the middle of the anterior lip of the glenoid cavity to the margin of the round foramen the distance in the fossil is 4·0, in the recent bone 1·1 c.m.

Assuming the length of the humerus to be a measure of the length of the entire animal the ratio between the two in Monitor would, if applied to the fossil, give a length of not quite 12ft. for the extinct reptile—compared with Hydrosaurus that l ngth would be increased to 14ft. 6in , while in comparison with Odatria it would attain 15ft. 6in. If, however, we take the breadth of the bone at the distral end as the basis of comparison, we attain in the same series of comparisons 18ft. 2in., 20ft. 9½in., and 25ft. 4in. Taking the mean of the results of the comparison with Monitor, with which its affinities seem to be strongest, we arrive at a probable length of 15ft. for the owner of this humerus accompanied, however, by a massiveness of body and limb not preserved in its modern representatives.

From the scapula alone, which from wide difference of locality could not have belonged to the same individual as the humerus, we should be compelled to estimate the entire length of

Notiosaurus as nearly four times that of Hydrosaurus, or about 18ft. 4in.

It is not difficult to conceive the part taken in the affairs of its day by this great lizard as well, or better, fitted for carnage on land as a crocodile of equal size in the waters. The functions of its dwarfed successors are twofold. Part of their work is to check the undue increase of all living things unequal to themselves in strength, agility, and courage. With limbs muscular in proportion to the weight of their gross bodies, and in length sufficient to obtain the necessary extent of grasp, they climb trees with facility and, squatting in ambush on the boughs, seize the birds as they alight for rest, plunder their nests of young or eggs, or search every hole and covert for nocturnal animals in their lairs. Equally at home on the ground, they are, when hungry (and in summer they are seldom otherwise), constantly roaming about seeking and devouring without waiting to kill, unless killing is neeessary to swallowing. Nothing comes amiss to them, and snakes are among their choicest morsels. In a word, if it were not absurd to deorate any one animal as the most efficient balancer of the pros and cons of nature, an Australian might be inclined to give the palm to the bush-wife's horror, the "gohanner,"—and this more especially when he remembers that the reptile's disposition is not only to lop the exuberance of animal life but to clear away the dead and mortiferous encumbrances left in its midst. The 'guana and the eagle are the scavengers of the bush—the latter gorges the carcasses fallen afresh in the forest, the former resorts to the putrifying remains beside creeks and pools and battens on the garbage till it can scarce remove its unwieldly body out of danger. And such, we may believe, would be one of the chief labours of love committed to the great 'guana of old. Its size, the shortness of its limbs, and the difficulty of satisfying its appetite with the puny frequenters of the trees, would be sufficient to prevent it acquiring arboreal habits; but while size and voracity at once impelled and enabled it to swallow whole the bulkier creatures of its age, and thin their numbers to equilibrium point, its powerful fore-limbs would aid it chiefly in its attack on lifeless prey—with their support and help the jaws would rend the flesh and tear apart the tendons of the dead Diprotodon and Notothere as easily as those of its descendant the remains of the kangaroo and bullock.

We may add that if the former conditions of life were as favourable to the numeric increase of Notiosaurus, and probably other such giants, as those at present in force are locally to Hydrosaurus and Monitor, human life in its pristine feebleness could hardly have made head against them. That man in any form was coeval with these great lizards is yet to be discovered; but the fact of his universal friend, the dog, being then in the land is too suggestive to allow us to put the idea aside. Is it possible that the absence from these drifts of human remains is related to the frequency of those great carnivors? Is it possible, also, that the legends of dragons and hydras are but echoes that have reached European shores of the struggles of naked heroes with their saurian foes in far away lands?

TOOTH.—(PLATE III.)

Curiously enough the preceding notes were hardly penned when fortune favoured the writer with a tooth of the same age and probably of the same species as the one indicated by the humerus. It was in a medley of small bones and fragments forming part of the Museum Collectors' gatherings during the last three weeks at Clifton, Darling Downs. Its opportune appearance is the more interesting in that it seems to strengthen one of the opinions formed respecting Notiosaurus. The teeth in Monitor, compared with those in Hydrosaurus, are broad and thick; the tooth of the latter is distinctly serrated on both edges, while in the Monitor tooth the fore-edge only is serrated, and that faintly. The outline of the tooth of the extinct lizard resembles that of Hydrosaurus, but it is proportionately thicker; its fore-edge is smooth and also like the Monitor tooth, it has the basal fluting extended higher on the inner side towards the crown than in Hydrosaurus. On the other hand, its shape and the almost entire want of the ridge descending upon the outer side of the tooth sufficiently differentiate it from that of a Monitor proper. We have, therefore, here additional evidence that the extinct lizard had greater affinity with the smaller than with the larger of these two living genera.

The length of this tooth is 2·1 c.m., its breadth 1·2 c.m.; the measurements of a middle tooth of Hydrosaurus are 0·6 c.m. and 0·3 c.m.; of Monitor, 0·3 c.m. and 0·2 c.m.; and from these elements of comparison we may estimate the entire length of the animal to have been in the mean 18ft. 6in.

DESCRIPTION OF A SPECIES OF ELEOTRIS FROM ROCKHAMPTON,

BY

C. W. De Vis, M.A.

A more frequent imitation of the example set by Mr. W. N. Jaggard, of Rockhampton, who is actively engaged in collecting the aquatic products of his neighbourhood, cannot be too highly recommended to all friends of knowledge: those, perhaps, more especially who are resident in the north. The observation, most prolific of discovery, is that of the local observer. Among several apparent novelities due to the zeal of Mr. Jaggard is one which I have no hesitation in bringing under your notice, as interesting in its kind. It is a member of the genus Eleotris; a genus, including a great number of species of small fishes: some among the commonest in our fresh water-pools and brooks: some found only in tidal waters. The numerous forms have for convenience sake been arranged in two groups: one with fewer, the other with more than fifty scales on the lateral line. Among those with fewer, that is larger scales, is a subordinate group of peculiar form, having a remarkably broad and flattened head; this group also contains the largest of the species hitherto found in Australia. That from Rockhampton, however, is considerably larger than its compatriots, and combines the broad depressed form of the one group with the small scales of the other. The following are its characters :—

ELEOTRIS CRESCENS, *n. sp.*

D 6, 1/9, A 9, Lat. 62.

The height of the body is $4\frac{3}{4}$ in the total length; the length of the head $3\frac{3}{4}$ in the same; the eye is $2\frac{1}{2}$ in the interorbit, which equals the snout; viliform teeth on the vomer and palatines perceptible to the touch, maxillary and mandibular teeth viliform with an outer row of strong short blunt teeth; general form robust, with the head concave between the nape and interorbit, convex over the muzzle and turgid on the cheeks. Lower jaw prominent. The maxillary reaches the level of the hinder edge of the orbit; gape rather oblique; bones of the head unarmed; anterior nostril tubular; head scaly to near the interorbit. The first five rays of the first dorsal subequal caudal peduncle deep, $2\frac{1}{2}$ in the length of the head; caudal a little rounded. Uniform blackish-brown above; lighter-brown beneath; the scales densely punctated with black. Length 14 to 16 inches. Three specimens. Locality, Rockhampton, Gracemere and other lagoons.

OBJECTS EXHIBITED.

The record for February, at Brisbane, of a self-registering barometer, with comments on the variations presented by the curve. By J. Thorpe, Esq.

An ant's nest, about two inches square, built of plant debris, and cemented to the under surface of the three terminal leaflets of a leaf—these leaflets being involved in the structure; accompanied by examples of the three classes forming the ant-colony, acari parasitic on the ants, and fungi growing on the ants' nest. This exhibit had been forwarded by Master H. Blackman, Breakfast Creek.

Mr. De Vis exhibited specimens of native chloride of silver, or "horn silver," from Silverfield, near Herberton, those derived from the more external parts of the reef or lode, being in the form of large nodules. He, at the same time, referred to the peculiar nature of the ore, its probable origin, its different portions of the lode, and the exceptional nature of the discovery.

FRIDAY, 10TH APRIL,

THE PRESIDENT, J. BANCROFT, ESQ., M.D., IN THE CHAIR.

NEW MEMBERS ELECTED.

A. Goering, Esq., Brisbane; F. Whitteron, Esq., Glenalbyn, Dalby; R. Spencer Brown, Esq., Brisbane; P. Fletcher, Esq., Brisbane.

DONATIONS ANNOUNCED.

"Final Report of the South Australian Institute for nine months ending June 30th, 1884" Adelaide, 1884. From the South Australian Institute.

"Descriptive Sketch of the Physical Geography and Geology of Canada," by Alfred R. C. Selwyn and G. M. Dawson; Geological Map of British North America, 2 sheets; "Comparative Vocabularies of the Indian Tribes of British Columbia," by W. Fraser Tolmie and G. M. Dawson. Montreal, 1884. From the Director of the Geological Survey of Canada.

"Bericht über die Senckenbergische Naturforschende Gesellschaft, 1884." Frankfurt a M. 1884. From the Society.

"Papers and Proceedings of the Royal Society of Tasmania, 1884." Hobart, 1885. From the Society.

"Contributions to the Natural History of the Bermudas, Vol. I." Washington, 1884. [Bulletin of the U. S. National Museum, No. 25.] From the Smithsonian Institution.

"Transactions and Proceedings of the Royal Society of South Australia, Vol. VII., 1883-84." Adelaide, 1885. From the Society.

"Report of the Auckland Institute and Museum for 1884-85." Auckland, 1885. From the Auckland Institute.

The following Paper was read :—

ON AN EXTINCT MONOTREME, ORNITHORHYNCHUS AGILIS.

BY

C. W. DE VIS, M.A.

(PLATE IV.)

IN the former existence in Australia of a rich and diversfied development of marsupial forms of mammals, and in the fact that the antique fish, Ceratodus, had then a less, probably far less, restricted range than at present, we may see reason to believe that the monotremes, their present associates, must have also been their comrades on the march from previous ages, and another hemisphere towards their shore of extinction on this the limit of their journey southwards. We have, in fact, been already instructed that one of the two divisions of these strange links in the chain of evolutionary effects was included in our newer tertiary fauna. Some years ago an arm-bone of a large Echidna was described by Krefft (An. & Mag. Nat. Hist. 1868, Vol. I , Page 113) under the names of E. owenii : in 1883 a similiar bone was in the hands of Sir Richard Owen, and to Krefft's species may possibly belong a claw-bone preserved in the Queensland Museum. To all who gave attention to the subject the discovery of some trace of a fluviatile monotreme comparable with the existing platypus must have seemed a mere matter of time and good-hap; and by time and good-hap the expectation has been fulfilled, and a relic has been found of an ancestor of the living ornithorhynchus. The bone, a right tibia of an adult, has been very lately received from King's Creek, in the vicinity of Pilton, where the Museum collectors were for a short time excavating. It shews no sign of having been inherited from a less modified, that is more reptilian, precursor; on the contrary, it possesses all the character of the genus as represented by *paradoxus*, fully matured and even more pronounced than in its descendant. It is, perhaps, worthy of remark that, presuming this tibia to be full-sized as well as adult, it indicates a species of smaller dimensions than the present one. If, then, the extinct species were the only one then existing, it formed an exception to the general rule, which maintained superiority of size in members of every group, compared with that of their modern representatives. It may not, therefore, be too rash to infer that the customary giant of its tribe has yet to make itself known.

Viewed in common with a recent bone of *paradoxus*, the specific distinctness of the fossil tibia is seen at a glance—a closer examination leaves, for the moment, a doubt on the mind whether its owner were, strictly speaking, an ornithorhynchus or of a genus nearly allied. The feature, which has been noted by Sir R. Owen as one of those distinguishing the tibia of ornithorhynchus from that of echidna, the curvature of the shaft, is in the fossil exaggerated, and the whole surface is more deeply impressed and sharply moulded by the muscles than in the living platypus. It is this circumstance which has suggested the specific name *agilis*.

The comparative measurements of the tibia in *paradoxus* and *agilis* are these :—

	paradoxus. c.m.		agilis. c.m.
Total length.................	5·65	...	4·85
Length of the head	1·4	...	1·25
Breadth „ „	9·3	...	0·275
„ of the shaft	0·5	...	0·45

The facet for the outer condyle is narrower, flatter, and, anteriorly, more distinctly separated by a groove from the precondylar tuberosity. It is also separated from the intercondylar area by a narrow and sharp ridge. The inner condylar facet (fig. 1, i.c.) is likewise more clearly defined by an extension forward of the depression, thus formed into a groove, on the inner side of the sunken "spine." By these inner and outer grooves the precondylar tuberosity is narrowed and rendered more distinct. The lateral edge of the inner facet which in *paradoxus* is produced into an angle overhanging the base of the head, and forming the extreme limit of its breadth, is in the fossil shortened and rounded, the head sloping downward and outward from it ventrad. The muscular impression on the hinder side of the shaft, below the head (fig. 1, m.), is deeper. It is bounded on the inner side by a ridge-like margin, and on the outer renders the ridge descending from the head much thinner than in *paradoxus.* On the outer side of the anterior surface of the shaft, the procnemial fossa or concavity (fig. 2, p.) is much longer, reaching downwards quite to the middle of the shaft. The distal end of the shaft is relatively narrower—its outer edge, opposed to the inner edge of the fibula, being less expanded. It is also more concave on both the facets of its hinder side, which are separated more markedly by a low ridge descending from about the middle of the shaft. As a consequence of the elevation of this ridge, and the contraction of the outer edge of the shaft, its form is more nearly trihedral than in the living species. The inner malleolus (fig. 2, i.m.) is proportionately smaller, and its summit hemispherical rather than oval. The curvature of the shaft is almost as great in the shorter as in the longer bone, and is, therefore, absolutely greater.

The sum of the differences observed would almost seem to be beyond the limits of specific variation; but on the evidence of this fossil alone it would be imprudent to propose a new genus for it. Other portions of the skeleton will, however, be sought for with increased interest.

Since the foregoing notes were made, a mandible (Fig. 3) has come to hand from the same spot as that which yielded the tibia. Both bones are of the same dark colour, and in the same state of mineralization. They, therefore, probably belong to the same individual. The mandibulary fossil is the distal half of the right horizontal ramus with the colander-like socket of the molar nearly perfect. In accord with the tibia, it shows a smaller and slenderer animal than *paradoxus* It is narrower in proportion to its length, and especially narrower in the postalveolar region. Other specific differences are patent in the arrangements of the perforated depressions and subdivisions of the alveolus. In the recent species, the pits in which are moulded the mammillary processes of the under side of the horny grinder are disposed in three groups, separated by low septa. The anterior of these contains two pairs of depressions, and one or two smaller subsidiary pits. The middle group consists also of two pairs of pits; and the third, confined to the posterior angle of the alveolus, of a single depression. In the fossil there are four groups, divided from each other by transverse ridges. The foremost contains two pits, the second also two, the third four, and the fourth a single pit. There are no subsidiary pits in the first of these, and the arrangement of the whole has more linear regularity and lateral symmetry than in the living species. The internal coronoid or pterygoid process is well developed. The inner angle of the jaw is rather more distinctly inflected than in the present representative of the genus. On the whole, nothing can be observed in this mandible to confirm the suspicion previously expressed that the extinct monotreme was something other than an ornithorhynchus.

OBJECTS EXHIBITED.

Samples of a cobalt ore, which had been found in quantity by Mr. F. Smith, at Kilkivan, and which Mr. De Vis remarked represented a "wad" or variable mixtures of the oxides of manganese, iron, and cobalt; the last-mentioned element being present, in selected specimens, to the extent of 22 per cent

The head of a buffalo, which had been presented to the Queensland Museum by Mr. H. Glissan, as being that of an animal which, after having roamed all the way from Port Darwin, during which journey it travelled from one herd of cattle to another, had been shot near Townsville.

A well-preserved incisor of Sceparnodon, from the fossiliferous drifts of the Darling Downs, which presented all the characters which were associated in a similar object which Professor Owen, under the name of *S. Ramsayi*, had recently referred to a tapir-like marsupial possessing persistent rodent teeth.

Dr. Bancroft exhibited the following interesting objects derived from his own and from the public gardens of the city, and including plants which he had been instrumental in introducing into the colony. Tubers of *Cyperus esculentus*, the *amande de terre* of the south of Europe, which in its manner of growth resembled the nut-grass *C. rotundus*. (Dr. Bancroft at the same time remarked that the small bulbs, which he had previously referred to as forming an article of diet amongst the blacks of the interior, and which were known as *Yowa*, had proved, on cultivation, to belong to a *Cyperus* allied to this *C. esculentus*.) An aquatic sedge, *Eleocharis, sp.*, as also affording a food substance. The farinaceus fruit of the lacustrine plant *Trapa bicornis*, the *ling* of the Chinese. Fruit of the candle-nut tree, *Aleurites moluccana*, as an article of food, and as a source of oil valuable for many purposes. The sweet succulent peduncles of *Hovenia elatus*, a Chinese fruit. Male and female inflorescence, and also seed pods of the Carob tree, *Ceratonia siliqua*, in illustration of its diœcius character. Papaw fruit from so-called "male tree," the same inflorescence having borne male and hermaphodite flowers. Pitchers of Nepenthaceous plants, including examples from Queensland species.

Other exhibits included a "Barogram" for March, by Mr. J. Thorpe, who drew attention to the periods of low pressure occurring between the 3rd and 7th, the 12th and 14th, the 16th and 19th, and the 27th and 31st, and also to the concomitant phenomena of wind and rain.

FRIDAY, MAY 8, 1885.

THE PRESIDENT, J. BANCROFT, ESQ., M.D., IN THE CHAIR.

NEW MEMBER ELECTED.

Alexander Archer, Esq., Brisbane.

DONATIONS ANNOUNCED.

"Journal of Conchology," Vol. IV., No. 9. January, 1885. From the Conchological Society.

"Victorian Naturalist," Vol. I., Nos. 15 and 16. Melbourne, 1885. From the Field Naturalist's Club of Victoria.

"Catalogue of the Library of the Royal Society of Tasmania." Hobart, 1885. From the Society.

"Procès-Verbaux des Séances de la Sociéte Royale Malacologique de Belgique." Tome XIII. Bruxelles, 1884. From the Society.

"Naturkundig Tijdschrift voor Nederlandsch-Indië." Deel XLIV. Batavia, 1885. "Catalogus der Bibliotheek." Batavia, 1884. From the Koninklijke Natuurkundige Vereeniging.

"The Victorian Irragationist," No. 9. Melbourne, 1885. From the Editor.

The following papers were read :—

A CONTRIBUTION TO THE FLORA OF MOUNT PERRY.

Part II.

By JAMES KEYS, Esq.

This paper, which is a supplement to a former one bearing the same title, and read before the Royal Society of Queensland in April, 1884, by Mr. F. M. Bailey, contains an enumeration of the plants which I have collected in the neighbourhood during the past year, and which have been identified from time to time by Mr. Bailey.

The district, whose flora I have thus attempted to determine, includes the Burnett Range and the ranges locally known as the Boolboonda and Normanby, with the irregularly shaped basin between, and covers an area of between eighty and one hundred square miles.

The geological formation of this district, though very varied, may be roughly described as consisting of three classes of rock, viz., porphyritic, of which the Burnett Range is chiefly composed, granite in the Boolboonda and Normanby ranges, and a micaceous slate predominating in the hilly country between.

The soil in general is such as an agriculturist would term "poor," being almost entirely composed of sand and the larger fragments of disintegrated rock; and the vegetation, except in the mountain gorges, is seldom very luxuriant; yet the number and variety of species, and the rarity of many, fully compensate, I think, for this want of luxuriance.

To the heterogeneous nature of the mineral constituents of the soil, may, in a great measure, be attributed the botanical wealth of the district. Of course, the diversity of elevation, ranging from 1000 to 2500 feet above the sea level, and the latitude—the place occupying as it were, the neutral ground between two different zones of vegetation—must also act as contributing causes.

From an examination of the former paper on this subject, in connection with the present one, it will be observed that the number of species of eucalypti is comparatively small, only eleven having been met with. The grasses also are comparatively few (32 sp.), and the more nutritious species are not well represented. With the exception of *Cynodon dactylon* (common couch grass) which abounds in the vicinity of the township, the more valuable varieties are sparsely distributed, the prevailing species being *Heteropogon contortus*, *Andropogon pertusis*, *A. refractus*, *Aristida ramosa*, *Sporobolus diander*, *S. indicus*, *Chloris divaricata* and *Perotis rara*.

On the other hand, the order Filices is well represented, no less than thirty-seven species having been met with.

In the scrub, which for some distance fringes the Burnett Range on both sides, the vegetation is of the most varied character, the prevailing plants being Lignum (*Vitex lignum-vitæ*), *Flindersia australis* and *F. Oxleyana*, both of which attain a considerable size; *Myrtus Hillii, and M. racemulosa*, *Notelæa Microcarpa*, *N. longifolia*, *Cryptocarya triplinervis*, *Alstonia constricta*, which here attains the dimensions of a tree 50 to 60 feet high; *Bursaria incana*, with its wealth of odoriferous flowers; *Excæcaria Dallachyana*, *Croton insularis*, *Harpullia pendula*, *Cupania* (four species), *Owenia venosa*, *Siphonodon australe*, etc., etc. The Moreton Bay Pine (*Araucaria Cunninghamii*) extends in some places from the base to the summit of the mountain, and in favorable situations attains a height of upwards of 150 feet.

In many of the glens which run far into the mountain are to be found the graceful palm, *Archontophœnix Cunninghamii*, *Panax elegans*, *Cedrela Toona*, *Dysoxylon Muelleri*, *Acacia implexa*, *A.*

penninervis, *Pithecolobium pruinosum*, *Abrophyllum ornans*, etc. with the Tree Fern, *Alsophila australis.*

On the summit are to be found the *Syncarpia laurifolia*, *Leptospermum flavescens*, *Acacia juniperina*, the prickly shrub, *Oxylobium aciculiferum*, and a eucalyptus which I have been unable to identify. *Xanthorrhœa arborea* is entirely confined to this mountain, the genus being represented in other parts of the district by X. quadrangulata.

On the western side of the range is a projecting spur whose summit is crowned with steep cliffs partly composed of a ferruginous sandstone. Here is the home of the beautiful Dendrobiums, *D. speciosum* and *D. monophyllum*, with the pretty *Bulbophyllum minutissimum*, spreading over the surface of the perpendicular rocks. Here also grow the newly-discovered species of *Hoya*,—*H. Keysii*, trailing over the cliffs; *Zieria Smithii*, *Prostanthera incisa*, and *P. ringens*, all of which seem to be confined to this particular spot.

On the low ground and the hilly country, the chief plants of interest are the cycads and macrozamias, *Erythrina vespertilio* with its showy orange colored flowers and the graceful *Acacia Bidwilli.*

It may be worthy of notice that the terrestrial Orchids of the district seem to be almost entirely confined to the slate and granite soils, only one species (*Dipodium punctatum*), out of the twelve enumerated, having been found elsewhere.

Of the plants mentioned in this paper, it will be observed that a few are entirely new to science. and that several others are either very rare or have not hitherto been found in the colony.

I cannot conclude these remarks without expressing in some degree my feeling of obligation to the Colonial Botanist, Mr. Bailey, for his unvarying kindness to me in all matters connected with this subject.

ORDER RANUNCULACEÆ.

Ranunculus lappaceus, *Sm.* (Common Buttercup.)

ORDER MENISPERMACEÆ.

Sarcopetalum Harveyanum, *F.v.M.*

ORDER CRUCIFERÆ.

Nasturtium officinale, *R. Br.* (Edible Watercress.)
Lepidium ruderale, *Linn.*

ORDER PITTOSPOREÆ.

Pittosporum undulatum, *Vent.*

"The oil obtained by distillation from the flowers of this plant has an agreeable, jasmine-like odor; but the taste is unpleasantly hot and bitter."

Bursaria incana, *Lindl.*

Citriobatus pauciflorus, *A. Cunn.*

ORDER CARYOPHYLLEÆ.

Polycarpæa breviflora, *F.v.M.*

ORDER MALVACEÆ.

Hibiscus radiatus, *Cav.*

ORDER RUTACEÆ.

Zieria Smithii, *Andr.*

Evodia micrococca, *F.v.M.*

ORDER MELIACEÆ.

Flindersia Oxleyana, *F.v.M.*

The wood of this tree is finely marked, and very durable, though liable to warp when exposed to the weather.

ORDER CELASTRINEÆ.

Celastrus bilocularis, *F.v.M.*

ORDER RHAMNEÆ.

Cryptandra amara, *Sm.*

This pretty little shrub, with its abundance of white flowers, would be well worthy of cultivation as a border plant.

ORDER SAPINDACEÆ.

Nephelium connatum, *F.v.M.*

Harpullia Hillii, *F.v.M.*

ORDER ANACARDIACEÆ.

Euroschinus falcatus, *Hook. f.*

Spondias pleiogyna, *F.v.M.* (Hog Plum.)

The timber of this tree when polished, is said to be scarcely distinguishable from mahogany.

ORDER LEGUMINOSÆ.

SUBORDER PAPILIONACEÆ.

Oxylobium aciculiferum, *Benth.*

Found only at high elevations.

Isotropis filicaulus, *Benth.*

Crotalaria juncea, *Linn.* (Sunn or Bengal Hemp.)

This plant, which attains a height of from 4 to 6 feet, is cultivated in India for the sake of its fibre, which readily separates from the stem after three or four days' immersion in still water. From the specimens met with, I should think that it would thrive well in cultivation on low lying or alluvial soil of moderate fertility.

Crotalaria calycina, *Schranck.*

Indigofera trifoliata, *Linn.*

,, viscosa, *Lam.*

Tephrosia reticulata, *R. Br.*

,, purpurea var. sericea.

Swainsonia galegifolia var. albiflora.

,, parviflora, *Benth.*

Desmodium polycarpum, *DC.*

Pycnospora hedysaroides, *R. Br.*

Glycine tabacina, var. uncinata, *Benth.*

Vigna luteola, *Benth.*

Flemingia parviflora, *Benth.*

SUBORDER CÆSALPINIA.

Cassia australis, *Sims.*

,, absus, *Linn.*

The leaves of this plant are said to have purgative qualities, and in Egypt the seeds are regarded as the best remedy for ophthalmia.

Cassia lævigata, *Willd.*

SUBORDER MIMOSEÆ.

Acacia juniperina, *Willd.*

Found only as an alpine shrub.

Acacia Cunninghamii, *Hook.*

,, salicina, *Lindll.*

,, harpophylla, *F.v.M.*

ORDER HALORAGEÆ.

Callitriche verna, *Linn.* (Water Star Wort.)

ORDER DROSERACEÆ.

Drosera Banksii, *R. Br.*

ORDER MYRTACEÆ.

Leptospermum flavescens, *Sm.*

Melaleuca leucadendron, var. saligna, *Linn.*

Eucalyptus siderophloia, *F.v.M.* (Narrow-leaved Iron Bark.)

Eucalyptus pilularis, *Sm.* (Black-butt.)

Eucalyptus sp.

Syncarpia laurifolia, *Tenore.*

ORDER LYTHRARIEÆ.

Ammannia pentandra, var. decussata, *Roxb.*

Lythrum hyssopifolium, *Linn.*

ORDER ONAGRARIEÆ.

Jussiæa repens, *Linn.*

ORDER PASSIFLOREÆ.

Passiflora aurantia, *Forst.*

,, edulis, *Sims.* (A stray from gardens.)

ORDER CUCURBITACEÆ.

Momordica balsamina, *Linn.* (Apple Balsam.)

Bryonia laciniosa, *Linn.*

ORDER UMBELLIFERÆ.

Hydrocotyle bipartita, *R. Br.*
Daucus brachiatus, *Sieb.*

ORDER RUBIACEÆ.

Plectronia barbata, *J. Hook.*
Spermacoce brachystema, *R. Br.*

ORDER COMPOSITÆ.

Brachycome microcarpa, *F.v.M.* (Brisbane Daisy.)
Conyza ægyptiaca, *Ait*
Epaltes australis, *Less.*
Ptercaulon sphacelatus, *Benth. et Hook.*
,, glandulosus, *Benth. et Hook.*
Gnaphalium japonicum, *Thunb.*
Helichrysum elatum, *A. Cunn.* (White Everlasting.)
Bidens pilosa, *Linn.*
Glossogyne tenuifolia, *Cass.*
Cotula australis, *Hook.*
Centipeda orbicularis, *F.v.M.*
,, racemosa, *Hook.*

The flower heads of both these plants have a strong, purgent and rather agreeable scent.

Erechthites arguta, *DC.*
Gynura pseudochina, *DC.*
Saussurea carthamoides, *Benth.*
Crepis japonica, *Benth.*
Sonchus oleraceus, *Linn.* (Sow Thistle.)

ORDER GOODENOVIEÆ.

Goodenia paniculata, *Sm.*

ORDER CAMPANULACEÆ.

Lobelia membranacea, *R. Br.*

ORDER OLEACEÆ.

Notelæa longifolia, *Vent.*

ORDER APOCYNACEÆ.

Alstonia constricta, *F.v.M.* (Quinine Tree.)

Parsonsia lanceolata, *R. Br.*
„ velutina, *R. Br.*

ORDER ASCLEPIADEÆ.

Hoya Keysii, *Bail.* Sp. Nov.

Found climbing over rocks. "This species differs from H. australis chiefly in the shape of the leaves, and in the short white pubescence with which they are covered." A very free flowerer.

ORDER BORAGINEÆ.

Ehretia membranifolia, *R. Br.*
„ acuminata, *R. Br.*

ORDER CONVOLVULACEÆ.

Dichondra repens, *Forst.* (Kidney Weed.)
Ipomea Quamoclit, *Linn.*

ORDER SOLANACEÆ.

Physalis peruviana, *Linn.* (Cape Gooseberry.)

ORDER SCROPHULARINEÆ.

Limnophila gratioloides, *R. Br.*
Artanema fimbriatum, var. alba, *Don.*
Vandellia alsinoides, *Benth.*

ORDER LENTIBULARIEÆ.

Utricularia flexuosa, *R. Br.*

ORDER BIGNONIACEÆ.

Tecoma jasminoides, *Lindl.*

ORDER ACANTHACEÆ.

Eranthemum variabile, var. molle, *R. Br.*
Justicia procumbens, *Linn.* var. peploides.

ORDER VERBENACEÆ.

Gmelina Leichhardtii, *F.v.M.* (The Beech.)
Vitex acuminata, *R. Br.*

ORDER LABIATÆ.

Moschosma polystachum, *Benth.*
Prostanthera incisa, *R. Br.*

Prostanthera ringens, *Benth.*

ORDER PLANTAGINEÆ.

Plantago varia, *R. Br.* (Plantain.)

ORDER AMARANTACEÆ.

Amarantus paniculatus, *Linn.*

Alternanthera denticulata, *R. Br.*

ORDER CHENOPODIACEÆ.

Rhagodia hastata, *R. Br.*

Boussingaultia baselloides, *H. B. et K.*

ORDER POLYGONACEÆ.

Polygonum barbatum, *Linn.*

,, hydropiper, *Linn.* (Water Pepper.)

ORDER LAURINEÆ.

Cryptocarya triplinervis, *R. Br.*

ORDER PROTEACEÆ.

Persoonia Mitchelli, *Meissn.*

ORDER LORANTHACEÆ.

Loranthus linophyllus, *Fenzl.*

Viscum angulatum, *Heyne.*

ORDER EUPHORBIACEÆ.

Poranthera microphylla, *Brongn.*

Phyllanthus subcrenulatus, *F.v M.*

Croton phebalioides, *F.v.M.*

ORDER URTICACEÆ.

Ficus eugenioides, *F.v.M.*

,, rubiginosa, *Desf.*

Laportea moroides, *Wedd.* (Smooth-leaved Nettle Tree.)

L. gigas, *Wedd.* (Stinging Nettle Tree.)

ORDER CONIFEREÆ.

Callitris Endlicheri, *Parlat.*

A Cypress exuding resin. A few of these trees grow on the summit of Boolboonda Rock, but nowhere else in the district.

ORDER CYCADACEÆ.

Cycas media, *R. Br.*

This graceful and interesting species is gradually disappearing from the district, a circumstance which I attribute to the destruction (1) of the cones by insects, (2) of the young leaves by marsupials, and (3) of whole plants, by boys, who often thoughtlessly cut them down, or otherwise injure them when they come in their way.

Macrozamia sp.

ORDER ORCHIDEÆ.

Dendrobium speciosum, *Sm.*
,, monophyllum, *F.v.M.*
,, pugioniforme, *A. Cunn.*
,, teretifolium, *R. Br.*

Bulbophyllum minutissimum, *F.v.M.*

Found covering the face of steep cliffs; never before found so far north.

Cymbidium canaliculatum, *R. Br.*
,, Hillii, *F.v.M.*
,, suave, *R. Br.*

From their mucilaginous properties these plants are known to bushmen as "Native Arrowroot," and are frequently used as a remedy in cases of dysentry.

Dipodium punctatum, *R. Br.*

Sarcochilus falcatus, *R. Br.*

Diurus alba, *R. Br.*
,, aurea, *Sm.*

Microtis porrifolia, *Spreng.*
,, parviflora, *R. Br.*

Pterostylis nutans, *R. Br.*
,, mutica, *R. Br.*
,, grandiflora, *R. Br.*

This species has not hitherto been found in any other part of Queensland.

Acianthus fornicatus, *R. Br.*

Caladenia carnea, *R. Br.*

" cærulea, *R. Br.*

ORDER BURMANNIACEÆ.

Burmannia juncea, *Solander.*

ORDER LILIACEÆ.

Smilax glycyphylla, *Sm.*

This plant is known in New South Wales as "Wild Liquorice" or "Sweet Tea," and is said to possess tonic and antiscorbutic properties.

Smilax australis, *R. Br.*

Anguillaria dioica, *R. Br.*

ORDER COMMELYNACEÆ.

Commelyna ensifolia, *R. Br.*

Aneilema acuminatum, *R. Br*

ORDER JUNCACEÆ.

Xanthorrhæa quadrangulata, *F.v.M.*

Hitherto supposed to be confined to South Australia.

ORDER PALMÆ.

Livistona humilis, *R. Br.*

ORDER AROIDEÆ.

Colocasia macrorrhiza, *Schott.*

This plant is the "Pitchü" of the Burnett aboriginals; the rhizomes, partially dried and roasted in the ashes, are eaten by them as food. The broad leaves are frequently used with good effect by European settlers as a vesicatory in cases of acute rheumatism.

ORDER CYPERACEÆ.

Cyperus lucidus, *R. Br.*

Fimbristylis monostachya, *Hassk.*

Scirpus supinus, *Linn.*

Lepidosperma concavum, *R. Br.*

ORDER GRAMINEÆ.

Paspalum breviflorum, *Flügge.*
Panicum uncinulatum, *R. Br.*
Andropogon bombycinus, *R. Br.*
Perotus rara, *R. Br.*
Cenchrus australis, *R. Br.*
Phragmites communis, *Trin.* (Common Reed.)

ORDER LYCOPODIACEÆ.

Psilotum triquetrum, *Swartz.*

ORDER FILICES.

Lygodium scandens, *Swartz.*
,, reticulatum, *Schkuhr.* (Scrub Snake Fern.)
Davallia pyxidata, *Cav.* (Hare's Foot Fern.)
Pteris tremula, *R. Br.*
,, aquilina, *Linn.* (The Common Bracken.)
,, attenuatum, *R. Br.*
,, falcatum, *Lam.*

Found only on rocks here and at high elevations.

Aspidium cordifolium, *Sw.*
,, aristatum, *Sw.*
Polypodium proliferum, *Presl.*
,, rigidulum, *Swartz.* (Common Rock Fern.)
Platycerium alicorne, *Desv.* (Elk's-horn Fern.)

ORDER MUSCI.

Dicranella Baileyana, *C. Muell.*
Macromitrium vagum, *Hampe.*
,, aurescens, *Hampe.*
,, diaphanum, *C.M.*
Bryum viridulum, *C.M.*
* Bryum pachytheca, *C.M.*
Pterobryum sulcatum, *Hook.*

The species thus marked (*) have not hitherto been found in the colony.

Meteorium kermadecensis, *C.M.*
,, filipendulum, *J. Hook. et Wils.*
,, amblyacis, *C.M.*
Neckera Baileyana, *C.M.*
Porotrichum vagum, *Hornsch.*
Thuidium læviusculum, *Mitten.*
Thuidium plumuliforme, *Hampe.*
* Gigaspermum repens, *Schwœgr.*
* Barbula calcina, *Schwœgr.*
* Rhacopilum tomentosum, *Brid.*
* Hypopterigium Scottiæ, *C.M.*
Entodon Mackayensis, *C.M.*
* Thamniella vaga, *Hook.*
* Leucoloma Sieberianum, *Hsch.*
Papillaria amblyacis, *C.M.*
Holomitrium Dietrichiæ, *C.M.*
* Weisia viridula, *Brid.*
Entosthodon cuspidatus, *C.M. Sp. Nov*
Sematophyllum Keysii, *C.M. Sp. Nov.*
* Trematodon suberectus, *Mill.*

ORDER HEPATICÆ.

Madotheca Godfrediana, *Gottsche.*
Metzgeria furcata, *Nees.*
Frullania Hampeana, *Nees.*
Marchantia polymorphia, *Linn.*
Fimbriaria australis, *Hook. et Tayl.*
Authoceros punctatus, *Linn.*

ORDER CHARACEÆ.

Nitella myriotricha, *Al. Br.*

ORDER LICHENES.

Leptogium diaphanum, *Mont.*
Cladonia aggregata, *Eschweiler.*
,, cervicornis, *Ach.*
,, macilenta, *Hoffm.*

Usnea longissima, *Ach.*
,, cornuta
,, dasypogoides, *Nyl.*
Ramalina minuscula, var. alba., *C. Knight.*
Parmelia reperata, *Stirton.*
,, revoluta, *Flk.*
,, olivetorum, *Ach.*
Physcia picta, *Nyl.*
,, speciosa, *Fries.*
,, chrysopthalma, *DC.*
,, stellaris, *Fr.*
Pyxine Meissnerii, *Tuck.*
* Pertusaria velata, *Turn.*
Lecanora (Aspicilia) melanommata, *C. Knight, Sp. Nov.*
,, Babbingtonii.
,, atra, var. immarginata, *C. Knight.*
Thelotrema enteroxanthum, *C. Knight, Sp. Nov.*
Cœnogonium botryosum, *C. Knight, Sp. Nov.*
Lecidea saxatilis
,, (Buellia) stellulata, *Taylor.*
,, (Biatorina) planella, *Nyl.*
* ,, Domingensis, *Ach.*
Lepraria flava.
Verrucaria aurantiaca, *Fee.*

ORDER FUNGI.

Agaricus campestris, *Linn.* (Common Mushroom.)
Marasmius confertus, *Berk. et Broome.*
,, rufo-pallidus, *Kalchb.*
Lentinus fasciatus, *Berk.*
,, Lecomtei, *Fries.*
Schizophyllum commune, *Fries.*
Polyporus luteus, *Nees.*
,, xanthopus, *Fries.*
,, perennis, *Fries.*

Polyporus arcularius, *Fries.*
„ melanopus, *Fries.*
„ cinnabarinus, *Fries.*
„ igniarius, *Fries.* (Used for tinder.)
„ hirsutus, *Fries.*
„ venustus, *Berk.*
„ grammocephalus, *Berk. et Br.*
„ lineato-scaber, *Berk. et Br.*
„ anebus, *Berk.*
„ gilvus, *Fries.*
Trametes devexa, *Birk.*
„ rigida, *Berk.*
„ pictus, *Birk.*
„ occidentalis, *Fries.*
Dædalea Sprucei, *Berk.*
Hexagona tenuis, *Fries.*
Stereum lobatum, *Kunze.*
Auricularia lobata, *Sommerfelt.*
Corticeum læve, *Fries.*
Clavaria rufa, *Fries.*
Hirneola polytricha, *Fries.*
Geaster minimus, *Schw.* ("Earth Star.")
Bovista lilacina, *Mont. et Berk.* (Puff-ball.)
Lycoperdon pusillum, *Batsch.*
Cyathus campanulatus, *Corda.*
Poronia œdipus, *Montagne.*
Aspergillus glaucus, *Link.*

ORDER ALGÆ.

Conferva floccosa, *Kuetz.*

ON A LIZARD AND THREE SPECIES OF SALARIAS, &c.

BY

C. W. DE VIS, M.A.

The Queensland Museum has been frequently indebted to two zealous friends, Mr. F. A. Blackman and Mr. D. Macpherson, for apparently new forms of vertebrates—more especially those which belong to tribes which are but too liable to be overlooked by observers to whom size or utility are the chief attractions.

Mr. Blackman keeps a watchful eye upon, amongst other things, the smaller lizards, and we have no reason to fear that his pursuit of them will cease for lack of interesting objects. That particular lizard for example which he now enables us to study is an addition to the number of lines connecting the Scincs with the Pygopidæ. The latter are one of the peculiarities of the Australian fauna, and it is in that fauna rather than any other that we may expect to find whatever intermediate forms may be extant, and several are already known, between the comparatively stout and strong-limbed Hinulias and the nearly limbless and snake-like Pygopus or Lialis. Every link of this kind is of great morphological interest: and, theoretically considered, adds another to the difficulties of special creation. The lizard before us, collected by Mr. Blackman at Breakfast Creek, near Brisbane, fails to effect an entrance into any one of the genera known to the writer. It is excluded from Lygosoma and its nearer allies by the absence of a visible ear; by virtue of its full complement of toes, together with its scaly lower eyelid, it stands apart from Cheilomeles; and even from its nearest affine the Javan genus, Podophys, it is differentiated by the simple squamation of its lower eyelid, the subrhomboidal form of its nasal, the non-triangular shape of its interoccipital, the unequal length of its toes, and the total closure of its aural orifice. We are therefore constrained to give it, provisionally, at least, a place and binomial of its own.

SCINCIDÆ.

LYGOSOMINA.

Calyptotis, *n.g.*

Habit, elongate, subcylindrical; limbs, distant, weak; toes 5/5 short, unequal, clawed; ear orifice, none; lower eyelid, scaly; supranasals, none; scales, smooth; nasals, lateral, distant, in a subrhomboidal shield.

CALYPTOTIS FLAVIVENTER.

Head, subtriangular, broader posteriorly than the neck, which is rather long. The rostral shield rises with an obtuse angle on the muzzle to the level of the fore-edge of the nasal orifice. The nasal orifice is round, and in the middle of the nasal shield. The prefrontal is long, covers the muzzle behind the rostral, and joins the loreal laterally with a long, straight suture. The base of the frontal is undulated to occupy the concave posterior edge of the prefrontal; its sides converge to an acute posterior angle. The parietals are trapeziums; the interoccipital is moderately large. Labials, 6/6. Two large temporals, the anterior descending between the fifth and sixth labials. Mental, large, succeeded by four pairs of submandibular shields, of which the anterior pair are mesially conjoined. There are twenty-two rows of scales at the middle part of the trunk. The scales of the back and belly are subequal and hexagonal. The mesial row of subcaudals is larger than the others. The preanals are but slightly, if at all, enlarged. The distance between the limbs is rather more than twice that of the fore-limb from the tip of the snout. The length of the hind limb is rather more than one-third of the distance between the limbs. Tail considerably longer than the body and head together, but variable in length.

Colour, above shining brown; on the back, six black lines, one traversing each row of dorsal scales; below, yellowish, with a conspicuous patch of bright salmon colour, or red, before or behind the vent; tail beneath, whitish, flecked with black; flanks speckled with black; face and lips with black and white. Length, 11 c.m. *Loc.* Breakfast Creek (*F. A. Blackman*); Macleay Island, Moreton Bay (*H. Tryon.*)

The very natural group of Blennies, passing under the name Salarias, though by no means so prolific in species foreign to Australia as the typical genus, is almost as numerously specialized in Queensland waters. What peculiar conditions may favour their multiplicity therein is yet to be ascertained—indeed, all the writer has been able to learn of their habits is that they hide beneath stones, or shells, or in the rock perforations left by boring mollusca, whence they dart out after their prey; that out of water they are extremely agile, leaping over the bare rocks, by the resilience of their scaleless body, in such a manner as almost to elude capture; and that they turn ferociously on the capturer, with the design, often successful, of burying their long fangs in unwary fingers. Several species have been recorded from Moreton Bay, and to these may now be added three which, as well as the rest, have been made known to us by Mr. D. MacPherson.

SALARIUS LUPUS.

D. 30, A. 20.

The height of the body and length of the head are each 5 in the total length. Dorsal not notched, higher anteriorly, the third ray being three-fifths of the height of the body, the web behind the last ray not reaching the base of the caudal fin. No crest on the nape, nor tentacles on the head. A short simple filament, half as long as the diameter of the eye, over the orbit; another, still shorter, at each anterior nares. Profile of nape and vertex, oblique; of muzzle, convex. Lower canines, large; upper canines, small. Caudal subtruncate, slightly rounded. Ground colour, yellow; immaculate on the caudal and pectoral fins; trunk densely marbled with blackish-brown, the marblings forming a line of nearly confluent large blotches on the back; dorsal and anal fins spotted on the rays. and marbled on the webs with blackish-brown; no definite markings on the head. This fish is closely allied to, *possibly* identical with S. viperidens, mihi, from Cape York. In describing that fish (Proc. Lin. Soc. N. S. Wales, Vol. IX., p. 697) I omitted to mention a short fimbriated tentacle on the orbit, and a pair of very short submental tentacles. The chief differences between *lupus* and *viperidens* are the simple orbital and nasal tentacles of the former, and the absence of submental filaments, the greater anterior elevation of the dorsal, deeper form, yellow-ground colour, and a much less development of the mandible at the base of the great canine—a conspicuous feature—in *viperidens.*

SALARIAS GALEATUS.

D. 30, A. 22.

The dorsal fin is distinctly emarginate. An elevated occipital crest is continued forwards between the orbits. A long lower canine is set unusually backwards towards the rictus. There is no upper canine. A row of papillæ surround the orbit, but tentacles are altogether absent. The height of the body is $5\frac{1}{3}$, the length of the head 5, in the total length. The head and trunk are much compressed. The anterior part of the dorsal fin is rather low; the posterior elevated higher than the body and subfilamentose. The caudal pointed and subfilamentose. Colour, dark brown, with black spots on the trunk disposed in irregular lines. The anterior dorsal with a series of dark oblique lines. The anal with or without short longitudinal white lines. On the trunk are mesially curved and backwardly elongated white lines, the most posterior forming two parallel lines on the caudal peduncle or these markings may appear as dark lines on a pale brown ground colour, which becomes still paler on the caudal peduncle.

SALARIAS FURTIVUS,

D. 34, A. 24.

The preabdominal height of the body is $6\frac{3}{4}$, the length of the head $6\frac{1}{4}$, in the total length; dorsal not notched, of uniform height, about half as high as the body, and not reaching the caudal fin. No crest nor tentacles whatever. Lower canines long; upper ones short. Anterior profile of head, from upper edge of orbit to the muzzle, rather oblique. Caudal fin, short, rounded. Ground colour, yellow, with three or four rows of small faint dark spots on the hinder part of the body, and a row on the back below the dorsal fin. Anterior dorsal, with a dark blotch on each ray and adjacent part of web near the base; soft dorsal, with three or four longitudinal dark stripes. A dark spot behind the eye. In a third specimen, the cheeks and chin are spotted; the spots on the body are more conspicuous and form a mesial line of larger spots of which the spot behind the eye is the commencement. On the other hand, the markings of the dorsal fin are faint. The anal is black edged.

OBJECTS EXHIBITED.

Dr. Bancroft exhibited—(1), Moths of a grass-green colour, which had been bred from specimens of a caterpillar which he had observed to be very destructive to the foliage of the "bitter-bark," *Alstonia constricta.* (Dr. Bancroft also alluded to the growing reputation which this bitter-bark was attaining, both in Europe and America, and stated that this was partly due to the fact that chemists in Germany had made it a subject of tho-ough investigation. He also remarked that it was likely to supersede both quinine and strychnia for the purpose of giving tonicity to the stomach in cases of fever). (2), A sample of a very valuable rice—the celebrated American "Golden Hull"—procured from plants which had been self-sown in a swamp near Brisbane. (3), A scapular of a large turtle, derived from an

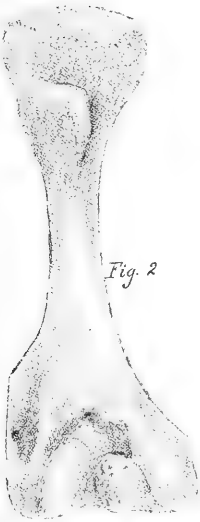

Fig. 2

Fig. 1.

H. Denniss delt.

Fig. 1 *Notiosaurus dentatus.* (Left humerus).

Fig. 1. *Notiosaurus dentatus.* (Left scapula).

Fig. 2. " " (Tooth).

Fig. 3. *Hydrosaurus giganteus* ".

Fig. 4. *Odatria punctata* ".

inner side

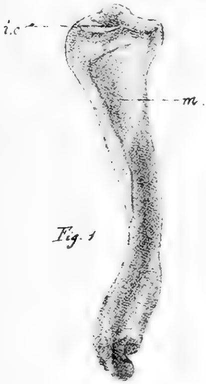

Fig. 1

outer side

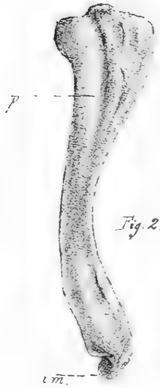

Fig. 2.

Fig. 3.

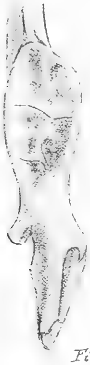

Fig 4.

H. Denniss del.

Ornithorhynchus agilis.

Fig. 1. 2. right tibia.

" 3. mandible.

" 4. " (O. paradoxus).

THE PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

QUEENSLAND.

1885.

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JUNE, 1886.

animal which had been stranded in the estuary of the Brisbane River

Mr. Alexander Turner exhibited the felted silken-investing web of a caterpillar's nest, which had been sent to him from the Maranoa district, where nests, similar to that from which the specimen had been derived, are very numerous, and drew attention to the favourable appearances of the silk composing it.

Mr. C. W. De Vis exhibited a sample of antimony regulus, which had been forwarded from Northcote to the Queensland Museum by Mr. Field of that district.

ANNUAL MEETING, FRIDAY, 24th JULY, 1885.

THE PRESIDENT, J. BANCROFT, ESQ., M.D., IN THE CHAIR.

The following REPORT OF THE COUNCIL and BALANCE SHEET were read, and afterwards, on the motion of L. A. BERNAYS, ESQ., F.L.S., etc., adopted :—

REPORT OF THE COUNCIL.

To the Members of the Royal Society of Queensland.

GENTLEMEN,—Your Council has pleasure in congratulating you on the satisfactory progress of the Society since the date of the last annual meeting.

On the books of the Society there are now 121 members—inclusive of 13, whose subscriptions for 1884 are still in arrear.

During the past year the Society has had to regret the loss of Mr. D. MacConnel, of Cressbrook, and Mr. A. E. Phillips, of Pine Hill.

A census of the Society gives the following results:—

Corresponding Members	1
Life Members (of late Queensland Philosophical Society)	13
Life Members (compounded)	9
Ordinary Members	96
Total	119

It will be seen from the Balance Sheet appended that the Finances of the Society are in a satisfactory condition, notwithstanding the fact that subscriptions due for the current year—amounting to forty-four pounds (£44)—have not been taken into account. Your Council would avail themselves of this opportunity to respectfully urge upon those Members, whose payments are in arrear, the desirability of retaining their membership.

On the side of expenditure will be found the item "Grant to Honorary Secretary, £25." This grant was made in July, 1884, on the recommendation of the Council, in consideration of services rendered in connection with the establishment of the Society.

The ordinary monthly sittings—ten in number—have been fairly attended. At these meetings twenty-six papers have been read on the following subjects:—

Ethnology	3
Hygiene...	1
Zoology	9
Botany (including Agriculture)	9
Geology (including Mineralogy and Palæontology) ...	4

Two of these Papers have been contributed by gentlemen who are not members of the Society. to whom, accordingly, your thanks are specially due.

In addition to these formal Papers, short notices on isolated subjects have, from time to time, been presented at the meetings. This method of communication might, we think, with great advantage, be more fully practised, as it permits of the permanent record of facts, often apparently trivial in themselves, but usually of considerable value to future investigators; and it is one which especially commends itself to Members who reside or travel in the country districts.

Your Council would direct your attention to the preponderance of biological subjects brought under your notice, and would hope that in future a Society, having very general aims, and composed of members representing many different professions, will be the means of publishing researches in many other branches of science. Such are the theoretical sciences, and Astronomy, Meterology, Geodesy, Geology, Geography, and Ethnology, with the different sub-departments of investigation which they comprise. They would, especially in a Society containing amongst its Members a large proportion of medical men, insist on the value of an investigation into the pathology of diseases, or phases of disease, peculiar to the Colony, as well as of its native materia medica.

So fully impressed is your Council with the importance of educing research in the directions indicated that, after mature consideration, they recommend the adoption of a rule providing for the formation of sections, or committees, to deal with special branches or subjects of inquiry, and they hope that the function of the Society may thus be more satisfactorily fulfilled.

The first volume of the Society's Proceedings has been issued to the Members, and distributed to societies and public scientific institutions, many of which have furnished in return publications, whilst others have expressed their willingness to do so.

By this system of exchange, and by the liberality of private donors, the library of the Society has been enriched by the reception of 100 books, pamphlets, or papers—received from 24 Societies, 4 Government Departments, and 19 individuals. Particulars of these donations have from time to time been announced to you in the monthly Abstracts of the Society's Proceedings.

Shortly after the date of the last annual meeting your Council appointed a Sub-committee to take measures (in conformity with precedent afforded by the actions of other Societies in similar cases) for securing to the Society the proper sanction for the use of the term "Royal;" and on its recommendation adopted the following petition to His Excellency Sir Anthony Musgrave, which was duly forwarded to him :—

To His Excellency Sir ANTHONY MUSGRAVE, Knight Commander of the Order of St. Michael and St. George, Governor and Commander-in-Chief of the Colony of Queensland and its Dependencies.

The Humble Petition of the Members of a Society provisionally entitled "The Royal Society of Queensland," sheweth unto your Excellency as follows :—

1. That your petitioners are a Society in the Colony of Queensland, having for its objects the furtherance of Scientific Research, and Publication of Papers on matters of Scientific Interest.
2. That the Society was formed at the commencement of the present year; and subsequently the Queensland Philosophical Society, which had been in existence for upwards of twenty years, became incorporated with it; and that it has already enrolled more than one hundred persons as members.
3. That it is the unanimous desire of the Members of the Society to obtain the gracious assent and approval of Her Majesty the Queen to the use by them of the title Royal Society of Queensland.
4. That a similar privilege has been granted to Societies of a kindred nature in the Colonies of Victoria and New South Wales.

Your Petitioners, therefore, humbly pray that your Excellency will be pleased to take such steps as may be necessary to obtain the gracious assent and approval of Her Majesty the Queen to the use by them of the title Royal Society of Queensland.

And your Petitioners as in duty bound will ever pray, etc.

Signed on behalf of the Members,

Henry Tryon, Honorary Secretary.

JOSEPH BANCROFT, President.

To a letter forwarded with this petition, and which contained also a list of the Members, and a copy of the rules of the Society, the following reply was received:—

GOVERNMENT HOUSE,
BRISBANE, QUEENSLAND,
29th December, 1884.

SIR,—I have the honor, by direction of the Governor, to acknowledge the receipt of your letter of the 19th instant and its enclosures, and to say in reply, that His Excellency has had much pleasure in moving the Secretary of State for the Colonies to obtain the necessary permission for the use of the title of "Royal Society of Queensland" by your Society.

I have the honor to be, Sir,
Your obedient Servant,
ANTHONY MUSGRAVE, P.S.

HENRY TRYON, ESQ.,
Hon. Secretary,
"Royal Society of Queensland."

And, at a more recent date, the subjoined announcement was received:—

GOVERNMENT HOUSE,
BRISBANE, QUEENSLAND,
6th May, 1885.

SIR,—I have the honor, by direction of the Governor, to acquaint you that His Excellency yesterday received a despatch from the Rt. Hon. the Secretary of State for the Colonies, desiring the Governor to inform you that Her Majesty has been graciously pleased to comply with the prayer that your Society may be permitted to assume the title of the "Royal Society of Queensland."

I have the honor to be, Sir,
Your obedient Servant,
ANTHONY MUSGRAVE, P.S.

J. BANCROFT, ESQ., M.D.
President,
"Royal Society of Queensland."

It is now incumbent on the Members to make the Society worthy of its title.

Signed on behalf of the Council,
JOSEPH BANCROFT, M.D.,
PRESIDENT.

17th July, 1885.

ROYAL SOCIETY OF QUEENSLAND.

Balance Sheet of Receipts and Disbursements for the Year ending 18th July, 1885.

DR.

	£	s.	d.	£	s.	d.
Balance, July 8th, 1884				141	8	9
To MEMBERS' SUBSCRIPTIONS—						
2 Life Compositions	10	10	0			
50 Annual Subscriptions	52	10	6			
2 Half-year Subscriptions ...	1	1	6			
5 Entrance Fees	5	5	0			
				69	7	0
				£210	15	9

CR.

	£	s.	d.	£	s.	d.
By Grant to Honorary Secretary, 18th July, 1884	25	0	0			
Printing and Binding Proceedings, and Miscellaneous Printing and Stationery	67	8	9			
Illustrating Proceedings	1	1	0			
Library	7	0	6			
Postage of Proceedings	6	18	2			
Advertising, Miscellaneous Postage, Attendance, and small Accounts	15	12	11			
				123	1	4
Balance				87	14	5
				£210	15	9

I, having this day examined the Accounts of the "ROYAL SOCIETY OF QUEENSLAND," find the above Statement to be correct, and that a balance of £87 14s. 5d. remains in the hands of the Treasurer.

22nd July, 1885.

(Signed) D. O'CONNOR, *Auditor*.

The following Presidential Address was then delivered:—

PRESIDENTIAL ADDRESS,

BY

J. BANCROFT ESQ., M.D.

It falls to my lot, gentlemen, as president of this society, to deliver an address on subjects of general interest to us as colonists, and members of the Royal Society of Queensland, and I am sorry the duty devolves on one who lays no claim to ability as writer or speaker.

We have recently by the favour of his Excellency Sir A. Musgrave, received permission from Her Majesty the Queen, to use the title "Royal Society of Queensland," and although some of you would have felt more content to call yourselves the Natural History Society of Queensland, we accept the more honorable designation, and hope you will make efforts so to work as to deserve the name adopted.

With regard to the late Queensland Philosophical Society, which has been amalgamated with the present society, I may state that in the year 1859 the nucleus of this Society met in the old hospital that stood on the ground now occupied by the Supreme Court. Its most energetic member, at that time, and founder was the late Dr. F. J. Barton. The chief efforts of the Queensland Philosophical Society were at first directed to the furtherance of the study of meteorology, and the establishment of a museum. In the earliest records of the society are to be found documents relating to the study of rainfall and water supply that are singularly applicable to the wants of the present time. Dr. Barton acted as meteorological observer to the colony, and died at his post as hospital surgeon, and his contributions to the records of the Brisbane Hospital may be studied with much profit. I have had occasion to examine the first case-books of this institution for the purpose of learning what were the ailments from which the earlier Chinese immigrants to this colony suffered. The particulars are most carefully recorded in them, and although Dr. Barton has not used the words leprosy and elephantoid disease, the descriptions he has detailed leave no doubt in the mind of any experienced surgeon who reads them, that several of the patients were confirmed lepers, and also that elephantoid disease was at this early date (1853) introduced into the colony. After the death of Dr. Barton the Rev. Mr. Bliss acted as secretary to the Philosophical Society, and compiled the meteorological statistics. He has since died in England. For many years Sir James Cockle, whose high rank as a mathematician was then as now generally recognised, was its president, and several very learned papers from his pen are to be found in the printed records of the Society. By the death of Mr. Charles Coxen the society lost an excellent supporter, whose investigations into the conchology and ornithology of Queensland, and whose study of the habits of bower-birds in particular have made his name famous. This reputation is shared also by the late Mr. H. C. Rawnsley, who wrote on this last subject, as well as on the lyre bird, in 1863-5. Mr. Sylvester Diggles was for many years a great supporter of the society, and did much to elucidate the entomology of Queens land. His publication of "The Ornithology of Australia," is well known. The late Mr. Tiffin, Colonial Architect, took much interest in the growing improvements in sanitary contrivances, and read a paper on the subject in the year 1866. Of the members of the society still living in Queensland I have no remarks to make, as they, it is to be hoped, will, at any rate by their contributions to the records of the Royal Society, prevent their names from being forgotten.

Of the subjects on which I had the privilege of reading papers on various occasions before the late Queensland Philosophical Society, I will refer to the following as suggestive of further research. The account of poisonous animals, which I wrote in

1866, was republished last year in the *Australian Medical Gazette* of Sydney, with the addition of a history of a new form of loss of sight (lasting for several weeks), which I alluded to under the term "tick blindness," as being caused by the bite of one of our poisonous scrub "ticks." Concerning *Pituri*, written in 1872, I should remark that this plant is not yet in cultivation in any Australian gardens. Its properties are apparently identical with those of tobacco, and it is not a little interesting to ethnologists—that these two plants, the only ones yet known to science as containing the poisonous nicotine alkaloid, should have been found out by rude races of mankind—the American Indians discovering tobacco ages ago in North America; and, for a time that cannot be computed, the central Australian using the far more powerful *Pituri* leaf to chew before undertaking any unusual exploit. My investigation of *Pituri* with that of Baron von Mueller led me to discover, in 1877, the mydriatic *Dubosia*, perhaps the most powerful agent known as a paralyser of the internal muscles of the eye, and yielding a drug which is now employed by ophthalmic surgeons all over the world to decide the question of the fixity of the pupil. In this connection I may mention a convenient drug for the purpose of paralysing the accommodation of the eye, in the straw-coloured liquid to be derived by pounding and subsequent pressure, from the large tubular petals of the trumpet flower (*Datura arborea*) which is grown in Australian gardens. When these petals are chewed by children a very flushed state of the features takes place with delirium and uncontrollable muscular action. Chloroform will put an end to this disorderly condition, and, as far as my experience goes, recovery may be expected. (I may here remark that the Indian and Colonial Exhibition Commissioners intend to forward a collection of Queensland drugs, which Mr. Staiger the chemist is engaged in preparing. Several of these drugs will be found very interesting and valuable additions to our native materia medica.)

In 1881, I brought a matter of some interest to botanical students before the Philosophical Society, and seeing that, as far as I am aware, there is no paper printed on the subject, I take this opportunity of mentioning it. In May of that year I was examining a brackish waterhole under the shade of an Avicennia tree, and observed that the surface of the water was strewn with a white flour-like powder. Seeking the source of the powder, I found it issuing from the rootlets of the Avicennia tree. These rootlets are pithy and full of air, and rise out of the mud at the foot of all Avicennias, or "white mangroves." I took rootlets with me for microscopic examination, and found numerous spots casting off white flakes of corky cells. Thinking that this had something to do with the circulation of air in the pithy rootlets, I attached a rubber cap, and on immersing the end of the rootlet in water, found air could be pressed from the cap and made to issue from the spots that were casting off floury particles. On comparing these spots with other similar excrescences, I found them to correspond to what are called lenticels, and, to make a long story short, that the corky incrustations on peaches and other trees are respiratory organs. My account of this discovery I sent to Professor Balfour, of Edinburgh, and he thought it sufficiently important to read it before the Royal Society of that city. Professor Balfour shortly afterwards died. The communication was commented on by the scientific papers of the time, and was mentioned in *Nature*. Some other botanist in France had just come to the conclusion that the lenticels were ærating organs, and in consequence of his claim to priority and my friend's death, the communication was not published by the Royal Society of Edinburgh, neither was my manuscript returned. I propose to submit my original paper on this subject to you at a future meeting, especially as this discovery has thrown important light on the function of lenticels and tends to clear up much that is obscure as to the hpysiological import of the extensive development of these organs which we find on apple, pear, peach, plum, and the great group of deciduous fruit trees; and as much of the scientific treatment of the stems of these trees depends on the correct knowledge of the functions of lenticels. Lenticels begin to open out between the fall of the leaf and the formation of new foliage. All greasy applications tend to close up these respiratory apertures, and lichenous growths starting amongst their corky cells seriously injure the growth of the tree.

Having made these few remarks concerning the past history of the Queensland Philosophical Society, and some of the work that it accomplished, I shall now speak of a few Australian affairs that interest us, after which I shall conclude with some local matters deserving of notice. Taking a general view of its position we find Australia occupying an increasing importance in the concerns of the British Empire, not so much by having contributed a handful of troops to assist the mother-country in the Egyptian occupation, but by giving extensive employment to British commercial energies, supplying the old country with meat, gold (not to mention other metals), grain, and, what is more than all these, homes for the homeless population of Great Britain to an extent surpassed by no other country on the face of the globe. The frozen meat trade, chiefly from New Zealand, now makes a perceptible impression in the supply of animal food for the city of London; and although the tinned, salted, and dried meats of former years have fallen into unmerited neglect, not satisfying the prejudices of the people, we may yet expect great results from them to both producers and consumers, filling up wants that no freezing process can supply. The boiling-down of thousands of prime animals for their tallow alone has become a thing of the past, which it will never again be necessary to have recourse to. The export of Australian wool gives much occupation for shipping, and as the country becomes more settled, and the production of fodder and the supply of water become better understood, much greater results may be expected. Of gold, Queensland alone has exported, in twelve years, in value, about £15,000,000 sterling. During the last year the yield diminished somewhat, but may be expected to increase, to which increase deeper sinking now being put under the direction of the Government will be an important auxiliary power. Then there are the other mineral sources of wealth with which Queensland is so richly endowed. With regard to the mining in this and the other colonies, hindrances, by taxation and other legislative measures, have been placed on Chinese occupying goldfields, as it was found that these people, who came here by thousands, elbowed out the Europeans. South Australia, however, has not woke up to the understanding of the value of a goldfield in attracting a European population. It is well known that the stimulus of gold has worked wonders in Queensland, and it is much to be regretted that in the Northern Territory of South Australia the mines are considered of no value, and are being ransacked by Chinese—a people who, removing the gold, go to China, leaving behind them improvements of no greater value than a bark hut and an earth dam. It is to be hoped that in the future Federal Council some effort will be made to rectify this wasteful conduct.

Grain our friends in the Southern Colonies find to be so cheap as to repay them poorly for their farming, and maize in Queensland realises a higher price per bushel than wheat in South Australia. We also find that wheats grown in India will grow in similar parallels of latitude in Queensland without destruction by rust, and whenever farmers chose to pay attention to the industry, breadstuffs may be easily grown to supply the wants of the colony. My paper relating to experiments on the growth of Indian wheats in Queensland was read to you a few months past, and with the assistance of the Government some extension of the industry may be expected.

Regarding the population, we find that the physical powers of our Australian youth are not surpassed by those in the Northern Hemisphere, and laurels were won by us in cricket and now in boating. The population of the Northern Queensland coast towns shows no signs of deterioration, and boys and girls born in the tropical latitudes that come to Brisbane to school are good samples of Australian youth. They are not so rosy as the inhabitants of Tasmania and New Zealand, but are their equals in physical endurance.

Confining myself more to local affairs and particularly to questions of health, I may state that the parasitic diseases due to the presence or hydatids and filaria, demand special remark. The latter (*i.e.* filaria) is a parasite that inhabits various structures of the body, and voids its embryonic brood into the circulating blood. It causes chyluria, lymphatic varicosities, elephantoid limbs and growths. Judging from the hospital records of the late Dr Barton, before referred to, I am of opinion that we are indebted to the earlier Chinese immigration for this parasitic disease—filaria—as well as for the less important affection, leprosy. Some years since—from 1876 to 1880—filaria disease was very common among our town children, some eighty cases being under my observation. I have now to chronicle that the investigations of the last five years show the disease to be extending little or no further in the city; the outlying towns where the water is defective contribute the only fresh cases of chyluria and lymph tumours that fall under medical treatment. Though this is not a medical paper, I may mention that in May, 1883, I verified the opinion that the disease called scleroderma was a form of elephantiasis, and was caused by the presence of filaria. The account of this discovery has formed the subject of a communication to Dr. Cobbold, of London. Mosquitoes take up embryonic filaria with the blood they suck, then carrying them to open tanks and wells perish in the water, which becomes polluted with filaria. The fact was discovered by Dr. Manson, of Amoy, in 1876-7. Dr. John Mullen, of Fortitude Valley, found the first case known here of chyluria in 1873, the late Dr. Thomas Rowland, observing the disease in Ipswich about the same time. I have a letter of his on the subject, dated 5th December, 1874. The parent worm was discovered in Brisbane in in December, 1876. Now that we have water from the reservoir at Enoggera and our tanks covered with metal gauze screens, wells and underground tanks being closed, we may expect the disease to diminish, especially if all doubtful water is boiled or properly filtered. Hydatid disease in the western country shows no sign of increase, though occasional cases occur. Only a few days ago I removed about half-a-pint of hydatid cysts from the back of a patient who had apparantly contracted the disease about sixteen years ago. This disease is much more common in the interior parts of the southern colonies, and would soon become a thing of the past if children were taught the danger of drinking pool-water to which dogs have access, for these animals are well known to transport the embryo hydatids to such places, having obtained them whilst feeding on the lungs and other organs of uncooked sheep, which are often infested with these parasites. An uncooked hydatid in the intestines of a dog leads to the development of a small tape worm. These tape worms live in the intestines for years, giving off eggs in the excreta of the dog. Eggs swallowed by a human being or sheep grow into hydatids.

Wells if kept properly covered should yield water safe to drink. Pure water is the most important thing produced by sanitary legislation, but our Health Act passed last session of Parliament did nothing to this end. Water is, of all commodities in this arid country, what should be guarded as a precious treasure; yet we see by some old Act, still in force, that slaughter houses must be built within 60 feet of the bank of creek. The clause reads thus:—

"And be it further enacted that no slaughter house, or place for slaughtering cattle, shall be licensed in any town unless within sixty feet of an accessible creek or river," if the same exist in the neighbourhood. See Statutes of the Colony of Queensland, Vol. I, Page 854, Clause XIV. This act ensures the pollution of every running water near a Queensland town.

We see tanneries and felmongeries pouring their filthy water direct into what were some years ago most lovely streams. Truly the so-called civilised man is little better, and in this respect is far worse than the aboriginal savage.

Children in England rarely drink water from brooks and pools, preferring to go to the first pump. Such habit inculcated in this country would be salutary.

Pure water at dairies should be insisted on, and careful inspection as to cleanliness. Typhoid fever has often been traced to this source. That it is very contagious there can be no doubt. Just recently the celebrated surgeon, Dr. Fortescue, of Sydney, was carried off at the early age of 45 by this disease. We have much to learn as to the nature of the contagion of typhoid. Over-exertion, whether mental or physical, by reducing the powers of the individual renders him prone to take the disease from slighter infection than would otherwise happen. New comers of limited means worry and work themselves into a state of feverish debility, often the beginning of typhoid. Some method of flushing the more extensive drains of the city should be contrived. Tanks (with a large escape plug) that would fill by a ball and tap might be suddenly emptied at the upper end of such drains; and if done late in the day, some of the bad smells in the lower parts of the city might be diminished, and their bad effects minimised. As to our present water supply, this could be relieved of much of its mud and impurities before being furnished to the inhabitants if proper reservoirs, where these matters could subside, were made on the hills in the immediate neighbourhood. As our education improves so we may expect our water supply. We can then wash and be clean; and to a better education a teaching university is necessary, where the arts and sciences of civilisation may have a home. The Botanic Gardens, it is to be hoped, will be reserved for this purpose; the Museum it is understood will be erected there, and space provided for its extension. We may then study rocks outside in the open air, and not be compelled to examine minute specimens in glass cases. Government House would be a fine site for the university; under the eye of Parliament it would not languish for want of the needful pecuniary support. Our students could have their boat races in the adjoining river, and so keep up their stamina. There is room on this plot of land for all needful adjuncts in zoology and botany, for the building of aquaria, for the study of mining, engineering, and mechanics. Given education, and all things are possible. From the study of botany alone great things may be expected, and in adapting suitable fodder plants to this widespread country our latent pastoral resources may be extensively developed.

A vote of thanks having been unanimously accorded to Dr. Bancroft for his presidential address, the following Officers and Council for the ensuing year were then chosen:—*President*, L. A. BERNAYS, Esq., F.L.S., etc.; *Vice-President*, A. NORTON, Esq., M.L.A.; *Treasurer*, W. D. NISBET, Esq., M. Inst. C.E.; *Hon. Secretary*, HENRY TRYON; *Council*, J. BANCROFT, Esq., M.D.; L. J. BYRNE, Esq.; C. W. DE VIS, Esq., M.A.; R. C. RINGROSE, Esq., M.A.; W. A. TULLY, Esq., B.A., F.R.G.S.

FRIDAY, AUGUST 7, 1885.

In the Presence of His Excellency, Sir Anthony Musgrave, K.C.M.G., Patron of the Society; L. A. Bernays, Esq., F.L.S., Etc., President, in the Chair.

NEW MEMBERS ELECTED.

Revd. W. E. Hellier, Clermont; J. Fenwick, Esq., Brisbane; Sir Thomas M'Ilwraith, L.L.D., K.C.M.G.; C. E. Chubb, Q.C., M.L.A.

DONATIONS ANNOUNCED.

"Russkago Geographitcheskago Obshtchestva" Transactions. Vol. XX. 1, and Vol. XXI:, 1, 2. St. Petersburgh, 1885. From the Société Impériale Russe de Géographie.

"Atti della Società Toscana di Scienze Naturali," Vol. IV., pg. 167-229. Pisa, 1885. From the Society.

"The Midland Medical Miscellany," Vol. IV., Nos. 41, 42. Leicester, 1885. From the Editor.

"Journal of Conchology," Vol. IV., No. 10, Leeds, 1885. From the Conchological Society of Great Britain.

"Results of Rain and River Observations made in New South Wales, during 1884," Sydney, 1885. From the Government Astronomer, New South Wales.

"Proceedings of the Linnean Society of New South Wales," Vol. X., Pt. 1, 2. Sydney, 1885. From the Society.

"The Australian Irrigationist," Nos. 10, 11, 12. Melbourne, 1885. From the Editor.

"Proceedings of the Nova Scotia Institute of Natural Science," Vol. VI., Pt. 2. Halifax, 1885. From the Institute.

"Proceedings of the Academy of Natural Sciences," 1885, Pt. 1. Philadelphia, 1885. From the Academy.

"Ninteenth Annual Report of the Queensland Acclimatization Society." Brisbane, 1885. From the Society.

"Transactions and Proceedings of the Victorian Institute of Engineers," Vol. I, II. Melbourne, 1874-84. From the Institute.

Twelve papers relating to Australian and Polynesian Conchology, by John Brazier, Esq., C.M.Z.S. (Pamphlets). From the Author.

"Descriptive Notes on Papuan Plants," by Baron Ferdinand von Müller, K.C.M.G., F.R.S., &c., No. VI. Melbourne, 1885. From the Author.

"Journal of Pharmacy," Vol. I., No. 1. Melbourne, 1885. From the Pharmaceutical Society of Australasia.

"Report of the Third Annual State Viticultural Convention." San Francisco, 1884. From L. A. Bernays, Esq., F.L.S., &c.

"The Chemical Compositions of Certain Rocks of New South Wales," and "On some New South Wales Minerals," by A. Liversidge, Esq., F.R.S. Sydney, 1880 and 1884. (Proc. Roy. Soc., N.S.W.). From the Author.

The following papers were read:—

THE PAPUANS:

COMPARATIVE NOTES ON VARIOUS AUTHORS WITH ORIGINAL OBSERVATIONS,

BY

WILLIAM E. ARMIT, F.L.S., F.R.G.S.

During my ramblings in New Guinea I devoted much attention and study to the different tribes with which I came in contact, intending to place my observations on record for comparison with those instituted by Wallace and D'Albertis —the only scientists who, as far as I knew, had published anything bearing on the Papuans as a race. Since my return to Queensland, however, I have received a contribution to this interesting and important subject from the pen of Dr. O. Finsch, who visited the South Sea Islands and New Guinea on behalf of the National Museum of Berlin in 1882. I intend here to give a resume of the leading observations of Wallace, D'Albertis, and Finsch, their deductions and conclusions, and to add my own experiences in the different portions of the islands visited. This will give enquirers and students the leading facts, as far as at present known to us, in a concise form, and enable them to compare them with their own observations or those of subsequent observers. It must be understood that I do not claim any undue importance for these notes as it will be patent to all, that many and more extended researches will have to be undertaken before any definite idea can be formed as to the origin of the Papuans as a race; *which* are the typical descendants of the original inhabitants of New Guinea, and *what* causes have led to the remarkable divergences from that type, which the explorer meets with wherever he may turn his footsteps.

Mr. A. R. Wallace[1] places the boundary line between the Malays and Papuans in the Island of Gilolo. In the vicinity of Sahoe he found a people differing in many respects from the Malays. These people were known as "Alfuros," and he describes them thus:—"Their stature and their features as well as their disposition and habits are almost the same as those of the Papuans; their hair is semi-Papuan—neither straight, smooth, and glossy, like all true Malays, nor so frizzly and woolly as the perfect Papuan type, but always crisp, waved, and rough, such as often occurs among the true Papuans, but never among the Malays. Their colour alone is often exactly that of the Malay, or even lighter. Of course there has been intermixture, and there occur, occasionally, individuals which it is difficult to classify; but in most cases, the large somewhat aquiline nose, with elongated apex, the tall stature, the waved hair, the

[1]The Malay Archipelago, 1 Vol. Edition, 1872; pp. 316-17.

bearded face and hairy body, as well as the less reserved manner and louder voice, unmistakeably proclaim the Papuan type. Here then I discovered the exact boundary line between the Malay and Papuan races, and at a spot where no other writer had expected it."

Subsequently Mr. Wallace visited the Ké Islands and was struck with the differences existing between the Malay and Papuan races, whose representatives he then saw for the first time.

He says:—"[1]The sooty blackness of the skin, the mop-like head of frizzly hair, and, most important of all, the marked form of countenance of quite a different type from that of the Malay, are what we cannot believe to result from mere climatal or other modifying influences on one and the same race. . . The Papuan has a face which, we may say, is compressed and projecting. The brows are protuberant and overhanging, the mouth large and prominent, while the nose is very large, the apex elongated downwards, the ridge thick, and the nostrils large. It is an obtrusive and remarkable feature in the countenance. The twisted beard and frizzly hair complete this remarkable contrast."

He was struck by the wild and boisterous conduct of these Ké men, so different from the taciturn demeanour of the Malays. Of the Aru Islanders Mr. Wallace remarks:— "[2]The natives here, even those who seem to be of pure Papuan race, were much more reserved than those of Ké." This he ascribes to having seen them only among strangers and in small parties; but, even under these circumstances, the typical characteristics could not be long repressed. Boys walked along singing or talking aloud to themselves quite a (negro characteristic).

[1]Ib. pp. 416-17.

[2]Malay Archipelago, 1872; p. 585 et seq

Mr. Wallace sums up his observations on the typical Papuan race—which he contrasts with the Malay—as follows:—"The typical Papuan race is, in many respects, the very opposite of the Malay, and it has hitherto been very imperfectly described. Colour of body, is a deep sooty brown, or black, sometimes approaching, but never quite equalling, the jet black of some negro races. It varies in tint, however, more than that of the Malay, and is sometimes a dusky brown. The hair is very peculiar, being harsh, dry, and frizzly, growing in little tufts or curls, which in youth are very short and compact, but afterwards grow out to a considerable length, forming the compact frizzled mop which is the Papuan's pride and glory. The face is adorned with a beard of the same frizzly nature as the hair of the head. The arms, legs, and breast are also more or less clothed with hair of a similar nature.

"In stature, the Papuan decidedly surpasses the Malay, and is, perhaps, equal, or even superior, to the average of Europeans. The legs are long and thin, and the hands and feet larger than in the Malays. The face is somewhat elongated, the forehead flattish, the brows very prominent; the nose is large, rather arched and high, the base thick, the nostrils broad, with the aperture hidden, owing to the tip of the nose being elongated; the mouth is large, the lips thick and protuberant."

The moral characteristics of the Papuan also separate him from the Malay.

"He is impulsive and demonstrative in speech and action. His emotions and passions express themselves in shouts and laughter, in yells and frantic leapings. Women and children take their share in every discussion, and seem little alarmed at the sight of strangers and Europeans."

Intellectually, Mr. Wallace places the Papuans above the Malay, although they had failed as yet in advancing towards civilisation. The comparison, however, seems to me rather invidious, as the Malay has for centuries been influenced by

Asiatic and Arab races, whereas the Papuans have been visited only by a few Malay traders, many of whom were little better than pirates—not likely to trouble themselves about the culture of the tribes they came in contact with. Even these wandering Bugis and Malacca men did not venture beyond the Aru Islands and the more northern portion of the great island of New Guinea.

Mr. Wallace noticed that the Papuan has more vital energy than the Malay; that he has a greater appreciation of art than his taciturn neighbour; but that, on the other hand, he falls far below him in the affections and moral sentiments.

"In the treatment of their children they are often violent and cruel; and this is due to the greater vigour and energy of mind, which produces a harsher discipline, and always, sooner or later, leads to the rebellion of the weaker against the stronger—the people against their rulers, the slave against his master, or the child against his parent."

Mr. Wallace's boundary line includes as Papuans the Alfuros of Sahoe and Galela in Gilolo, those of Ceram, of Bouru, of Timor, Flores, and Sandlewood Islands, and of Timor Laut (Tenimber Islands), the Ké Islanders, those of Aru (although these have been mixed with strains of European blood, which are traceable, according to that eminent naturalist, to the Portuguese and Dutch, and also with the Chinese and Malays, who have for more than two centuries made Dobbo the head-quarters of their yearly trading expeditions). Of course, New Guinea is the centre of the race, being by far the largest and most densely populated island in the region inhabited by the Papuans.

In the above description of the physical and moral aspects of the typical Papuan, Mr. Wallace makes the large aquiline nose a distinctive racial characteristic, which my own extended observations do not corroborate. That it obtains in the north and north-west, is indubitably certain. It also occurs fitfully along the south-east coast of New Guinea, notably among the Motu-Motu and the Motu of Port Moresby, and the tribes at Hula. But inland, this feature is noticeable by its very rare occurrence. I noticed but few instances of it among the Koiari, the Ekiri, the Sogore, and Maroca tribes.

The Havéri, Favéri, Dédouri, and Seramina tribes also struck me as being of a different type to the Motu, not only in the shape of the nose, but more especially in the absence of the the terrific chevelure, which among all these inland tribes never attains the size or colour, of which a Motu warrior is so proud.

No doubt this large aquiline nose, in approximating the face to that of some Europeans, imparts a peculiarly intelligent expression to those who possess it; but it is no more typical of the race than such a form of nose would be typical of an European.

Besides the tribes I have just mentioned, I also enjoyed ample opportunities of studying the people of Teste, Bentley, Dinner, Heath, Blanchard, Hayter, Basilisk, and Moresby Islands, of the D'Entrecasteaux, Engineer, and Redlich Groups, and of Milne Bay and East Cape (on the Island of New Guinea).

The large aquiline nose of the Papuan Gulf was only of very rare occurrence at all these places. A few individuals were noticeable through its possession, and invariably *appeared* more intelligent than their broad and flat-nosed compatriots. But this was only in appearance, for this superior intelligence had no foundation in fact, and these men were often more stupid and duller of apprehension than others whose looks did not raise any futile hopes.

I have also seen Roman and Jewish forms of noses among several tribes. The former generally imparted a stern look to the men, and reminded me forcibly of a Red Indian; while the latter brought the Jewish type of face into my mind, as soon as I gazed on it.

Many of the Papuans I have seen would pass muster as pure negroes, or natives of the Soudan.

I may here mention, incidentally, that a boy who was taken home from New Britain by Dr. Finsch, and introduced by him to the leading German ethnologists and anthropologists, was at once put down as an African! This will give you an idea of the riddle which scientists have to solve before the origin of the Papuan race can be traced.

Signor D'Albertis' work on New Guinea bristles with notices of the natives at the different spots visited by him during his several expeditions. It would be impossible in this paper to quote all these, but a few collated from the mass will suffice to give an idea of his theories touching the Papuans as a race.

In the forest on the coast of Emberbaki, he met a family of Alfuros. These people differ very widely from the Alfuros of Gilolo, described by Wallace. They were hunting, and are described as follows:—"[1]There were two men, two women, and several children. They showed no fear of me, and I went quite near to them. . . . The men were tall, and their skins very black; the women, whose skins were perhaps still blacker, had engaging faces; they were, I may say, even pretty, notwithstanding their blacker colour. Their features were by no means defective. They had not long, but, on the contrary, rather round faces. They appeared stout, and well fed, and I observed that their breasts were beautifully shaped and rounded. Their eyes were remarkably fine . . . Their hair was curly and unkempt. . . They are of a type sufficiently resembling that of the people of Dorey to be recognised as akin to the latter."

"[2]At Ramoi, a little village on the coast of New Guinea, a few miles from the sea, there is a small population which may be considered of almost pure blood. These people are very dark in colour, of low stature, with woolly hair, small eyes, and flattened noses. They seemed to me the poorest people in the

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[1]"New Guinea, Vol. 1, p. 66."

[2]New Guinea, by L. M. D'Albertis, 1881; Vol. 1 pp. 215-16.

world and the gloomiest. I was there a fortnight and never saw one of them laugh. . . . . . Some people from the interior came to this village, and they appeared to me to differ materially from the Ramoi men. They were not so dark, were of smaller size, and more prognathous. Their hair was divided into numbers of little tufts and rolled on bits of bamboo."

Speaking of the Arfaks of Audai, he says:—"[1]They are a fine race, tall of stature, and strong, and physically they seem superior to the inhabitants of the coast. They offer more homogeneity of type, and may be considered as the type of the mountain tribes. Their hair is exceedingly thick, black, and woolly, but so covered with grease that its real colour and nature is hidden. I occasionally met with men who had thick, though not long, beards, and their bodies covered all over with hair. The body hair has a reddish tint. Their skin is very dark, almost black, without being actually so. The forehead is, in general, narrow and somewhat retreating. The cheek bones are very high, and projecting beyond the eye orbits. The nose is almost always aquiline; the lips are well formed, but with a tendency to project; the chin is small and pointed. The women have rounder faces, less retreating foreheads, and less depressed temples, for which reasons the cheek bones do not appear so prominent as in the men."

At Battulei and Comul, at the extreme north point of Aru, D'Albertis found "a population of a special character which seems to be a distinct branch of the so-called Papuan family."[2] He, however, does not include the chiefs, who are of Malay extraction. These people differ from any of the Papuans the Italian explorer had met, and are described thus:—"[3]The men's figures are not only slight, but elegant and well proportioned in every limb, and they have an open and unem-

[1]Ib. Vol. 1 p. 217.
[2]New Guinea, Vol. 1 p. 219.
[3]New Guinea, Vol. 1 p. 220.

barrassed manner which shows that there is a mental as well as physical difference between them. Their features are more regular, though they cannot be said to attain to European outline, they recall the Arab cast of feature. Their skin is less dark than that of the people we have hitherto seen, their hair not so crisp—it is indeed often worn in long ringlets, their features are less harsh and hardly at all prognathous. Though the forehead is retreating, it is not so narrow, nor are the temples so depressed as in the people we have previously seen."

There can, I think, be little doubt that these people are not true Papuans, and that at some period, more or less remote, a mixture must have taken place either with the early Portugese or Dutch settlers, which is even now slowly giving place to the preponderating element of the Papuan race. The fact that the hair is not seldom worn in long ringlets is, to my mind, a convincing fact of such admixture of foreign, and presumably European blood, as in no case have I ever observed or read of true Papuan hair being worn as above mentioned. Its frizzly nature at once precludes the possibility of its adaptation to the form of a long ringlet. Signor D'Albertis next reviews the natives of Orangerie Bay, who, at the time of his visit in 1872, were remarkably friendly, eager to trade for dim-dim, as they called iron, and now call white men, and with whom not the slightest unfriendliness occurred. Now, after a lapse of little more than a decade, the Orangerie Bay coast is the most dangerous in New Guinea. These friendly people have been goaded into hostility and reprisal by the harsh treatment of unscrupulous white men, who, under the guise of friendship, robbed them and outraged their women.

"[1] We are at Orangerie Bay—a crowd of people surrounds us, here again we find a mixture of type. The colour of this people is lighter than any we have hitherto seen, but all are

[1]New Guinea, Vol. 1 p. 221.

not equally light—some are more, some less so. Their hair is not woolly, but is crisp. In the case of some individuals, especially women, who wore it short, it looked like smooth hair. There are aquiline noses here, but that shape is less common than at the Aru Islands and in the north-west of New Guinea. The people are smaller in stature, the head is rounder, and the outline of the face is more regular.

"They are a people living, as it were, in the age of stone; for although they know of iron by the name of "dim-dim," they possess none, and all their instruments are of stone, or bone, or wood. From this it might be thought that they have kept themselves from all contact with foreigners. But, on the contrary, among all the tribes whom I visited, this one presents the greatest confusion of type. It is certain that *two races*, perhaps equally savage and primitive—although I am not able to say which two—have come into contact here and have produced the present population."

Here D'Albertis seems to have been fairly puzzled by the diversity of what he calls type, but which to almost any one accustomed to the inland tribes would appear only as individual variations from some original type, variations due, I believe, to marriages between individuals of tribes far removed from each other, assisted, no doubt, by climatal and dietetic conditions. No one who has lived among these semi-savages has failed to observe the peculiar bias their females possess of being carried away by their emotions when admiring any object which has pleased their fancy. This is very noticeable when a visitor from some distant tribe arrives in a village. Should he be a comely man, from their point of view, which I need hardly say differs very widely from our own art-rules, they openly declare their admiration of the new comer, to the annoyance of their own admirers, who resent this sort of desertion in the most marked manner. I believe that slight differences in typical Papuans are due entirely to sexual selection, for I have noticed these reproduced in the offspring in several cases which I took the trouble to watch.

The theory of mixed races does not hold good in searching out the origin of the true Papuan. Had such a mixture of two, or more races taken place, it must have occurred during a period so remote that the offspring of such mixture or mixtures would, through future crossings, have been eventually absorbed into one or other of these races, and would leave no traces of the weaker or suppressed race for future observers. It would, I believe, be puerile to expect or even suppose that the races would be so evenly balanced that each could retain its own typical characteristics, and at the same time co-operate in the formation of a third or hybrid race. Such ideal conditions may read very well on paper, but they cannot exist in nature, certainly not among members of the human race.

I think therefore that the many different tribes which, in the aggregate, make up the Papuan race of the present day, have in themselves all the necessary ingredients which, through time, have eventuated the present inhabitants of Papua without having recourse to the theory of a conquering race or races having left an indelible brand upon the original indigenes of the soil.

It now remains to quote Signor D'Albertis' views regarding the natives of the Fly River, the last portion of New Guinea explored by him—

"[1]At Kiwai we have a prognathous people with small round heads, low and very narrow foreheads, zygomatic arch and upper orbits very strongly marked, and the temporal bones excessively depressed.

"Near Canoe Island we found, at only fifty miles from Kiwai, a prognathous but otherwise completely different type; the skull flattened at the top and extremely long from back to

[1]New Guinea, L. M. D'Albertis, 1881; Vol. 2 p. 377.

front; forehead, where it existed at all, retreating; the prominence above the eye-orbits, so greatly developed in the skulls of Kiwai, is entirely absent, and the temporal bones less depressed than in the first named type.

"In the interior we found the natives hardly at all prognathous, the skull still smaller, and the forehead high and almost perpendicular; moderate zygomatic arches, the eye-orbits scarcely marked, and the temporal bones very little depressed; the skull somewhat long, but not much flattened.

"From this it is evident that at least three distinct types are in existence, although they may, perhaps, belong to one series."

Here this eminent naturalist is entirely at fault. The three races, or types, are clearly referable to one original, or, at all events, constant type, that which occurs inland.

Signor D'Albertis was, evidently, unaware that the people of Kiwai, Taibai, and Katau practice the custom of artificially flattening, kneading, and moulding the skulls of infants into the shape they consider the most beautiful. It follows, therefore, that all such crania are valueless from a classification point of view. But I believe that anthropologists are beginning to realise the fact that the cranial shape in widely-separated races often approximates so closely as to render it impossible to discern one from the other. There occur also such a diversity, such a number of aberrant forms, that it becomes a matter of extreme difficulty to decide which skull, even in a very extended series from one spot, should be considered as typical. The day is not very far distant when the cranium will be discarded in favour of something presenting more constant characteristics, the presence or absence of which would enable the observer to arrive at some satisfactory decision.

Of the inland natives, D'Albertis writes:—"[1]We perceive, however, with surprise that these people of the interior are

[1]New Guinea, L. M. D'Albertis, Vol. II., p. 378.

farther advanced towards civilisation than those dwelling nearer to the sea. We find them using cloth, finely hand-woven of bark-fibre; cement is used to fasten together the component parts of their arrows; and also various kinds of varnish, showing a great advance on those people who only employ red or yellow earth, lime, or charcoal to colour and adorn their ornamental work."

West of Katau dwell some tribes which are constantly at war with the people of Moatta, and these, Signor D'Albertis considers, belong to a distinct type. "[1]These skulls came from Badu-hubere, and are remarkable for being much flattened at the sides, for their length, for their weight, and for other strongly marked characteristics, which indicate that they belong to an excessively low type."

In reality, these skulls merely prove that a different form of cranium being considered fashionable among the tribes from which they were captured, the infants are subjected to the process necessary to secure that form.

It is, however, interesting to note that this practice of artificially kneading the skull into any desired shape is in vogue among the tribes inhabiting Australia, and we may believe that it has found its way across Torres Straits to the mouth of the Fly River, and, presumably, along the coast on either side for some distance. There is no appearance, however, of its being practised in the interior, which, I believe, is easily accounted for, as the natives on the coast are constantly at war with the so-called bushmen. These, I believe, from my own observations made at the headquarters of nine distinct tribes between Port Moresby and Coguila, exclusive of the Motu tribe, which is a coast tribe, or the Koitapu, who have become amalgamated with their thievish neighbours, represent the typical Papuan race as found throughout the south-east peninsula of New Guinea.

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[1]Ib. Vol. II., p 381.

They outnumber the coast tribes, and are, in many respects, superior to them, morally and physically.

But even in a given tribe the explorer invariably finds so many individual variations from what he considers the typical form, that he becomes sorely puzzled to form any distinct idea—unless, indeed, he remembers that even in a crowd of Europeans the same diversity of form is, invariably, found, ranging from the dolycocephalic to the brachycephalic type, and including innumerable variations and aberrations from either type. Prognathous and orthognathous people are met with at every turn, and yet no one doubts for a moment that they belong to one and the same race. The same remarks apply to colour. Many white men approximate very closely to Creoles—using the term in its present acceptation—yet no one would care to inform them that they had a strain of black blood in their veins.

I think, therefore, that it only tends to complicate matters if we take note of every shade of colour, or peculiar formation of cranium, met with in New Guinea. The fact that for centuries, perhaps for ages, the Papuans have been separated throughout the length and breadth of the Island into numerous distinct tribes—nearly every one of which has its own dialect, its own habits and customs, differing in a greater or lesser degree from those of its neighbours, with whom a constant, or almost constant, though desultory war is carried on—accounts for many of the variations, which are so noticeable at present.

Had we found New Guinea governed by one independent sovereign, forming one nation instead of hundreds of independent tribes, speaking one language instead of, as at present, numerous dialects, we should not hesitate to own them as one race. Now, however, we speak of black, brown, and white Papuans, of Alfuros, of the indigenes of the interior, as if these were all distinct races; and to further complicate matters, Mr. Ranken talks of Mahori invaders—a collective name adopted to include a mythical wave of conquerors from the eastern race of brown Polynesians, although it would puzzle anyone to tell how or when these people came to New Guinea.

I now come to the observations instituted by the eminent ethnologist, Dr. O. Finsch, who made the study of the Polynesian races a speciality for a period extending over a number of years (1879-1882).

Dr. Finsch not only took measurements of representative types wherever he went, but also obtained a large series of plaster-casts of living subjects, and numerous photographs of both sexes, the whole collection thus brought together containing 200 plaster-casts, 300 crania, 200 samples of hair, 300 photographs, and many outlines of hands and feet. As a scientific contribution to the ethnology of Oceania, this collection is, I believe, unsurpassed.

It is a pity that our own Governments do not combine to obtain equally valuable materials towards the enrichment of our national collections before the advent of the white man renders the collection of these valuable and interesting curiosities no longer possible, by reason of the introduction of iron and steel, of beads and calicoes, among the races of the different island groups. Even at Sogore, sixty miles from Port Moresby, the chief, Bia-Irican, told me that when Mr. Goldie first paid his people with hatchets they threw all their stone axes and adzes away. I subsequently found some of these in the plantations, and beside the paths leading from village to village. It behoves us, therefore, to take time by the forelock if we desire to see the life-history of this interesting race depicted in our Museum.

[1]Dr. Finsch is of opinion, after studying different tribes in New Guinea, from the north-west to East Cape, including Salwattee, the Islands of Torres Straits, Saibai, Elema, near Cape Possession; Maiva, in Hall Sound; Port Moresby, the Koiara of Astrolabe, the Sugairi or Sogore, of the Upper Laloki,

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[1] **Anthropologische Ergebnisse, O. Finch, Berlin, 1884, p. 38 et seg.**

Kabadi, on the Aroa River, Hood Bay, and Aroma Districts, that there is no reason to believe that any mixture of races has ever taken place among the people at present inhabiting the island.

He includes the people of New Britain, New Ireland, Solomon Islands, the New Hebrides, the Loyalty Islands, and Fiji as belonging to the true Papuans.

To these must be added the inhabitants of the Louisiade Archipelago, who differ in no respect from the Papuans of New Guinea.

[1]Dr. Finsch describes the Papuan or Melanesian as being of a deep brown, and not seldom as black as a typical negro or as light as a Polynesian or Malay. These light-coloured varieties are referable to individual variation, although sometimes occurring in whole families. In no case can they be said to be the result of a mixture of races. In fact, he declares that he never came in contact with a tribe of Papuans which gave him the impression of being the result of a crossing of different races. He is of opinion that a cross between the Papuan and Polynesian races is invariably reabsorbed into one or the other of these races by further crossing. He is also of opinion that the same thing occurs in the case of a mixture with Europeans.

He also quotes the occurrence of light-coloured varieties among coloured races, and notably among the Cingalese who, he maintains, are as dark as Melanesians. He noticed the occurrence of light-coloured individuals in nearly every tribe visited, but they were of more constant recurrence and in greater numbers on the south-east coast of New Guinea. Here also he noticed the strange fact that not seldom a light-coloured tribe was sandwiched between two other tribes much darker than itself. He found the Papuan skin as smooth and soft as that of Europeans.

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[1]Ib. p. 34.

Their hair is subject to considerable variations in colour and texture. He also notices that the distribution of the hair over the scalp is the same in Papuans as in Europeans, and that, therefore, the tufty growth, or grouping, of the hair as a racial character must be rejected.

Generally, the frizzly variety of hair is the most noticeable. The straight-growing hair assumes, after a very short growth, a cork-screwy form, and becomes, by degrees, a thick, woolly, mass or mop, which imparts a negro-like appearance or element to the Papuan.

Besides this finely-frizzled hair, he notes the occurrence of coarsely frizzled, wavy, curly, crimpy, and quite straight hair, all these varieties occurring quite naturally, without any artificial help.

Although the usual colour is dark brown to black, it varies quite as much as the texture; the ends are often chestnut or rust-brown, and in children often quite blond; but even in these little flaxen heads the roots are invariably dark brown or black.

These natural and important aberrations in the texture and colour of the Papuan hair are further intensified by the application of artificial means, as we hardly ever find it worn in its natural state.

In many tribes it is dressed with lime, wood-ash, vegetable dyes, and other extraneous substances, which completely alter its original colour from dark brown to reddish-brown or dark saffron-yellow, or cause it to become matted into a number of greasy locks. In other tribes where no artificial applications are considered fashionable the hair is constantly and carefully combed by means of the well-known six or eight pronged comb, which soon changes its texture. This also occurs through the many artistic or grotesque methods of wearing the hair in vogue at different places, and differing even in the sexes of one locality, and these causes render any hard and fast description of Papuan hair as a predominant racial character impossible.

There is not, as a rule, any large growth of body-hair, and even this is checked and altered by the use of lime, depilation, shaving or plucking, but under normal conditions there is generally a sufficient and sometimes even strong growth of beard, which is mostly composed of very coarse, frizzled, dark hair.

Generally the Papuans, or, as Dr. Finsch prefers to call them, the Melanesians, have the appearance of being a powerful well-built race of middle size. Their limbs are evenly proportioned, the back-bone is bent inward, the belly is generally protuberant, owing, no doubt, to an almost entirely vegetable diet, the limbs are disposed to fleshiness, as in Polynesians, they lack muscle; the calves are generally well developed, but exceptionally, they are nearly wanting in individual cases, as in Australians. Very fat individuals, so noticeable among Polynesians of advancing years, especially in women, are very rare among Papuans, who then generally become thin and haggard.

The peculiar length of the prepuce in men from New Britain struck him as very remarkable. It attained a length of 25 m.m. to a total length of penis of from 80 to 112 m.m. The head is generally well formed, except in those districts where it is artificially deformed, the forehead is broad and straight, the cheek bones are scarcely prominent, sometimes not more so than in Europeans. They are seldom more prognathous than whites. The eyes are mostly full, handsome, and dark, the whites being always yellowish or blood-shot. The form of nose is the same as in the Polynesians, being commonly flat, the tip obtusely rounded, with broad, strongly-arched alæ, and large, oval, slantingly-placed nostrils; but there occur also aquiline, and more rarely bent, and even Roman noses, which impart an Indian aspect to the physiognomy. The shape of the mouth does not differ from that in Polynesians; the lips are, generally, a little full, making the mouth appear rather large, but this feature is not seldom as small as in Europeans. The colour of the lips is generally brown, showing a slight tint of red, but in young people, and particularly in children, it is not seldom red, although never as fresh and clean as in whites.

The breasts are well developed and shapely in youth, leaning mostly towards fullness, and generally hang after the first accouchement. The women, as a rule, wither rapidly, and appear very ugly to our eyes, the more so owing to the want of clothing, and very often to the clean-shaven head.

The fierce and savage appearance of Papuan warriors is due, in a great measure, to the fantastic and barbarous paints and decorations used by them for the purpose of striking terror into their foes. Generally, the facial expression of Papuans varies from the serious to the careless or stupid. In young girls it generally denotes an utter freedom from care, and a happy disposition. One often meets among them, as generally among any young people, very friendly and pleasant faces, and among the children there are many lovable pretty little creatures.

The negro-resemblance in the Papuan is due, in part, to the broad nose and large mouth, but more particularly to the dark skin and frizzled hair, *and must be considered an important racial characteristic.* This likeness is so striking that he himself mistook the first Papuan he saw—a man from Espiritu Santo—for an African negro. It may also be remarked that this likeness to the negro is more remarkable among the women than among the men.

Writing of the natives of New Guinea, Dr. Finsch considers that the immense mop-head, which attains not seldom a height of 11 inches, is erroneously considered a racial characteristic, instead of, as it really is, a fashion which is restricted to certain districts. In support of this statement he quotes the case of young girls who, brought up at the mission station, have succeeded by the constant use of European combs—very different articles from the Papuan many-pronged forks—in producing real curls from the frizzly hair with which their heads were originally clothed. The method of combing in vogue among Papuans is to stick the comb into the hair and bring it out with an upward jerk. They do not comb their hair downward as we do.

The mean of 40 measurements gave:—For men: height, 1.52—1.875m.; women: 1·39—1.49m. Circumference at breast, men: 0.82m. to 1.2m.; women: ·75—·85m. Cranium, men: 173—195m.m.; women: 172—189m.m.

Corpulence was of very rare occurrence. The fattest woman measured, named "Marewa," was 1.49m. high; circumference of breast, 91c.m.; of belly, 90c.m.; of thigh, 43c.m.; of calf, 32c.m.; of humerus, 22c.m.; breadth of shoulders, 42c.m.; head, 176m.m. And this woman was certainly an exception.

The most noticeable fact in the foregoing observations is the wide diversity of opinion between any two sets or between them as a whole. Wallace gives the average height of Papuans as equal to that of Europeans, while Dr. Finsch states that they are below middle height, and this certainly is borne out by my own observations. Wallace describes the Papuan as wanting in the moral characteristics, and charges him with cruelty towards his children. This may occur in the north-west, but there has been a co-mingling of races in that portion of New Guinea which accounts for this. Wherever I have been the most noticeable trait, and one which forced itself on my mind, was the uniform kindness and affection of the men for their children. It was a common sight to see men nursing babies, dandling them, fondling and kissing them, and romping with little toddlers of from four to ten years of age. It struck me that child-life in New Guinea was exceptionally happy and free from care. The women also are treated respectfully and kindly by the men. To us they appear to be very hard worked, but the men do their share of the heavy labor, and then leave their women to attend to the rest while they hunt, fish, or build canoes. As a whole I consider the Papuans a kindly disposed people, who dislike war and quarrelling, and love to live in peace and contentment. The only case which came under my notice of a man ill-treating a woman was at Teste Island, and this man was an elder of the congregation established there by the L. M. Society.

The children are bright, trustful little beings who love to be made much of, and who seem to be capable of a high state of culture.

Signor D'Albertis invariably takes refuge from puzzling questions on the derivation of the by him so-called diversity of type under the shadow of the far reaching theory of intermixture of two or more races, and this leaves him always stationary. No doubt intermixture has taken place in a few instances in the north-western portion of the island, but any such can be easily traced.

In the tribes about Port Darwin and Port Essington the Malay element is clearly traceable, although no prahus have visited the Australian coast for many years.

It may be, therefore, that having noticed a crossing of races in the Arru and Ké Islands, and also at other points in the north-west, Signor D'Albertis has unconsciously leaned towards this theory in making his observations.

There can, I believe, be little doubt that the people inhabiting the southern end of New Guinea and the adjacent islands have for a very long period of time been isolated from other races. This leads me to the opinion that they are all of one race, and that what we call diversities of type (or aberrations from the typical Papuan) as recognised by the large aquiline nose, the immense mop of frizzly hair, and the dark-brown colour of the skin are in reality not variations but individual peculiarities belonging to tribes living at a great distance from each other.

Variations which no doubt are due to sexual selections working within very confined limits, and under conditions peculiarly favourable to the creation of tribal peculiarities. This is I believe the cause of the many differences noticeable in travelling in New Guinea.

The Motu tribe is remarkable for the uniformity of colour, and for the wonderful head of frizzly hair and aquiline noses of its members.

The Koiari, living only a few miles from them, differ markedly in these characteristics. They have no immense mop of hair, but wear it wrapped up in a piece of tappa, have a flat obtusely pointed nose, and are either very dark skinned or as light as Malays. They are also shorter in stature than the Motu, although physically and morally immeasurably superior to them.

Dr. Finsch mentions the curious fact that a light colored tribe is often sandwiched between very much darker tribes. I visited one of this description, that of Morocca, whose territory is situated on the watershed of the Laloki and St. George rivers under Mount O'Bree, 80 miles E.S.E. of Port Moresby.

These people were remarkably light in colour, approximating to the Malays, and in individual cases to Europeans. The form of nose prevalent among them gives them a decidedly Jewish appearance—yet I could not find any proof of crossing with other races. The neighbouring tribes were the Sogore and Ekiri on the north-west and north, and the Havéri and Favéri to the southward. These tribes were many shades darker than the Moroccans. Among the Sogore a few light colored individuals were noticeable, but even among all these tribes no two possess exactly the same shade of colour, and many variations are noticeable in any given tribe. In some tribes the head is shorn as a sign of mourning, in others, the anterior portion of the skull is shaven by most of the men; in nearly all tribes, married women and children keep the head clean shaven as a rule.

Dr. Finsch records meeting four white Papuans at Hula, one of whom he describes:—The man was named "Kwarinam"; height, 1.61m.; circumference of breast, 93c.m.; skull, 182mm.; colour of skin, as light as in Europeans; the portions most exposed to the sun, bright red, sunburnt; the lips coloured as in whites; nearly the whole body sprinkled with small, dark, freckle-like spots; eyes, yellow-brown, possessing the full-seeing power even in full sun-light. This man was descended from dark-brown parents, was married to a dark woman, by whom he had two dark children.

The following is his description of the now celebrated chief, Koapinna, of Aroma:—Height, 1.81m.; skull, 195mm.; circumference at breast, 1.02m.; thigh, 55c.m.; calf, 40c.m.; humerus, 33c.m.; color of skin, light-brown; the shape of his nose, which unfortunately has become altered by deep pock-marks, gives him an Indian appearance; his walk and carriage are dignified; he has decided features; a well-proportioned, powerful body; large hands and feet; a splendid, well-kept mop of hair, which is black; and dark-brown eyes. His beard and body hair wanting owing to depilation.

This chief's name is not Papuan, but simply our own word "Captain," which has become altered to "Koapinna."

At Teste Island, where I resided on several occasions, I became acquainted with a white Papuan, whose wife also resembled a European in color. Their hair was curly, not frizzly, and of a light chestnut color. They had two children, a boy and a girl, the former was to all appearance a white boy, and I could hardly believe in his Papuan parentage when I first saw him. He looked just like a white lad who had been running about naked in the sun—sunburnt from top to toe. His sister was a shade darker, and her Papuan origin was at once patent. Although only 5 years old she gloried in a splendid mop of very finely frizzled chestnut hair, whereas, her brother's was smooth and curly.* Her eyes were very large, round, liquid, and dark-brown. His were oval, smaller, and blueish-grey.

At Moresby Island I knew a white Papuan, "Bailalla" by name, who had served in an American schooner for five years. He had visited Sydney, Melbourne, Adelaide, and Hobart. He knew most of the Island groups in the south seas by name, spoke English remarkably well, and was a very shrewd, intelligent fellow. In colour he was more like a Chinaman than a European. His hair was coarsely frizzled, very long and well-kempt, and of a rich golden yellow. His nose was large, bent slightly; the septum thick and fleshy; the alæ not very broad, owing to the fact that he seldom wore the heavy nose-stick of Tridacna shell; the nostrils large, oval, and slanting; body hair and beard wanting through depilation. His wife was also very light colored, her hair being finely frizzled. They had three children, two of whom were quite dark-brown and in nowise distinguishable from the usual dark type; the third and youngest, a boy, was lighter than either of his parents, and would have passed for a white child if properly dressed. His hair was quite smooth, and curled quite naturally. No lime or other extraneous substances were used by these people for anointing the hair, cocoa-nut milk being the only dressing applied to it. I could quote other equally striking cases which came under my observation in S.E. New Guinea or the adjacent islands, but I think the above will suffice to prove that so-called white Papuans are in nowise distinct from their darker neigh-

*In every case which came under my notice the base of the hair in light coloured or white Papuans was invariably dark-brown or black. In the case of two half-bloods, both girls, at Port Moresby and Bentley Island respectively, their fathers being Europeans, the color of the hair was very fair and constant to the very base, not bi-coloured as in the white Papuans. Their eyes also differed, being grey and blue respectively.

bours. The fact that their offspring is as often dark as light coloured proves this conclusively. White children having dark, often black parents, and *vice versa*, do not fulfil the conditions we should expect from a distinct race. To be pure they ought naturally to breed children resembling themselves, on the old maxim that "like begets like." We may therefore dismiss this portion of the subject as being fully cleared up, as far as the question of racial differences is concerned. But it remains a subject of the greatest interest to naturalists to trace the cause of this abnormal deviation from recognised natural laws to its source. This will be difficult until we know more of these interesting people, especially of the inland tribes.

When at Seramina, I heard of tribes inhabiting the northern and eastern slopes of Mounts O'Bree, Brown and Clarence, who wore a species of very finely netted kilt, and who possessed very beautiful weapons. These tribes were feared by the people I was living with, and they requested me to lead my men into their territory, and shoot as many as I possibly could. For obvious reasons, I was forced to decline this expedition, although I longed to meet these mountaineers in all friendliness —a meeting which, I flattered myself, would have been mutually beneficial to those concerned.

I have come to the conclusion that the coast tribes of New Guinea are morally far beneath their inland neighbours. Wherever I have been, they invariably proved themselves adepts in the art of thieving. This circumstance necessitated a careful watch over one's belongings, which was most annoying. Inland, however, this objectionable trait disappeared. The people were as honest as the day; only on two occasions did I miss anything. Once, at Dédouri, on Mt. Belford, I lost a belt-strap, and again at Morocca, in returning fever-stricken to Sogore, when the escort stole several hatchets and other steel implements. I was too ill to even notice the occurrence, but two days after our arrival at Sogore, the Favéri men arrived with the stolen goods, which they had forced the thieves to return, on pain of their being attacked by their more powerful neighbours. I made them a present of the whole lot, adding other things to the gift, so that none went away empty-handed. The Morocca people are head-hunters of the worst type, and it matters not to them whether the victim is a woman or child, they slaughter indiscriminately.

The coast tribes bury their dead in front of their houses, in very shallow graves. The widow sleeps on the decomposing body of her husband, and anoints herself daily with the putrid juices of his body. Her relatives and friends join her in this horrible ceremony, which is repeated for several days. The mourners shave their heads, and blacken their bodies all over with burnt cocoanut-husk ash. The women wear a neck-lace and ear-rings of the seeds of *Coix lacryma* during their widowhood, which, in some tribes, lasts for seven years.

The inland tribes place the body on a tressel over a shallow trough, and allow it to remain there for three or four days, until it has swollen nearly to bursting. An incision is then made, and the juices are expressed and collected in the trough. The friends and relatives, being in attendance, are led up singly to this, and, dipping their hands into the terrible liquid, they anoint their faces, hair, and bodies with it. Then a banquet takes place. Where the appetite comes from deponent knoweth not. The body is then slowly smoke-dried until it resembles a mummy. It is then rolled in aromatic herbs and tappa, enclosed in a hammock, and hung up in the common room, where it remains until some other member of the family dies. It is then carried to the tribal vault, generally a cave, or, failing this, to some hut which answers the purpose of a mausoleum, and is there laid reverently beside some other skeleton.

The people are excessively jealous of any stranger intruding upon the privacy of their dead. Nothing would cause a disturbance more suddenly than the discovery of such intrusion;

and this is entirely owing to the superstitious awe which attaches to the dead, whose spirit is supposed to hover about the haunts it frequented during its earth life. The inland tribes have no religion, but they believe in a life hereafter, although this is restricted to this world. They have not the imaginative energy necessary to carry them beyond their own immediate surroundings, and have but little leisure and less taste for abstruse philosophical theories.

The women are chaste, modest, and very shame-faced. Prostitution is not permitted, hence syphilis is unknown. None of the tribes I visited understood the manufacture of Kawa or any other inebriating beverage,—drunkenness is, therefore, unknown.

The food used by the inland tribes consists mostly of vegetables. Yams of different species, taro (two species), sweet potatoes (introduced by "Peri," the native teacher at Boïra), cucumbers and pumpkins (introduced by Mr. Andrew Goldie), bread fruit (the true seeding tree, not the seedless variety of the Malay Archipelago), betel nut, and indigenous wild fruits, ferns and fungi, are among the most common. Sugar-cane is very largely cultivated, several varieties occurring. Tobacco seems to be indigenous in some places, and to have been introduced into others. In many districts it is entirely wanting. Salt is eagerly sought after, and forms the staple article of trade with the coast tribes, who obtain it by evaporating salt water, but it does not form part of their daily food, being used only on gala occasions.

At Sogore, and again at Seramina, I made the very curious discovery that Manihot utilissima was known to the people, who had it growing near their villages. How it found its way into these remote parts of New Guinea, I was unable to learn.

Cotton grows luxuriantly in many places where it is cultivated for the sake of its flowers. Dracœnas, Crotons, Coleus, and other plants are similarly cultivated for decorative purposes.

A species of spearmint is used at Moresby Island as a perfume for dressing the hair.

Turmeric I found in cultivation at Kabadi, where it is used to dye the women's petticoats. The bark of a mangrove is similarly used, as also for tanning nets, lines, and cordage.

The inland tribes depend for their meat supply on the wallaby (Dorcopsis), which they succeed in capturing either with the spear or net. This is eked out by the occasional slaughter of a pig, a dog, or of both.

On the coast they are fishermen, using well-made nets and also spearing the fish. The sea yields them a never-failing supply of wholesome and palatable food, which in many places is further supplemented by the spoils of the chase.

The inland natives are agriculturalists, and consequently averse to roaming about. They live in villages, building remarkably comfortable, and often elegant, houses which generally stand on piles several feet above the ground. But even here life and property are hardly safe from the attacks of neighbouring tribes, and to guard against these and secure a place of refuge, tree-houses or *dubus* are built in every village. These are reached by means of ladders, the last fifteen foot length being drawn up, and thus securing those above from harm. These tree-forts are well stored with stones, a perfect hail of which would put almost any foe to flight. At the village of Ouri-bohi-bohi in Sogore, I ascended into a *dubu* 120 feet from the ground. I often watched mere children of four or five years scrambling up the steep ladder to their roost, quite as if it were a matter of course. How many European children of that age would attempt the feat?

The greater portion of the New Guinea tribes are still in the stone-age. Their weapons consist of spears, bows and arrows, shields, and heavy stone clubs, through which a hole is bored to admit the handle. These clubs are decidedly artistic, and much time and trouble are expended in their manufacture. They are of many shapes, often a mere disk whose cutting edge would crash through a skull as if it were an egg shell, others are stars not unlike the heavy "Morgenstern" of the middle ages. They are wonderfully true, and this has often astonished me, considering the primitive tools at their disposal. They are generally of (obsidian), but I have seen quartz clubs bored and beautifully embossed. Slings are also used. Charms are much worn and firmly believed in, they are purchased from sorcerers who make a fortune easily, by gulling the people.

The people on some portions of the coast are adepts in the art of canoe building. They sell these to their neighbours and purchase food with the proceeds. Many coast tribes do not cultivate sufficient to supply their yearly wants, and depend on that account on trade to make up the deficiency. They undertake yearly voyages to distant parts in search of sago, yams, and other produce for which they in return give pottery, stone axes, adzes or clubs.

In south-eastern New Guinea a small "coin" is highly esteemed. It is made from some kind of shell, and is worked up into necklets, bracelets, and other ornaments. The Teste Islanders call it "New Guinea money."

The manufacture of pottery is carried on largely at Annuapata, Port Moresby, and also at Teste Island, as also at many other places on the coast. Inland, however, wherever I went I found the natives using the primitive stone-oven, just as our own aborigines do at the present time. Yet the Koiari could obtain pots from the Motu for a mere song!

The Papuans are very fond of music, but it cannot be said that they have attained even the rudiments of the art. They can make a most hideous noise, and their singing consists of a droning, monotonous repetition of a few words which, as often as not, are excessively indecent. The hour-glass shaped drum is conspicuous everywhere in New Guinea. A very primitive pipe is made from a reed, and I have also seen a sort of Jews-harp made of some very hard wood. The men are more vain than the women in this curious style of society, and they spend hours daily plucking out hairs, jerking their mop-heads into shape, and besmearing their faces with a bituminous substance, which has the appearance of lacquer. They dearly love variegated leaves, flowers, and ferns, and are scarcely ever without one or more blossoms of the scarlet Hibiscus stuck in their hair or armlets. These are beautifully plaited from the stems of a fern, a species of Gleichenia, which abounds almost everywhere in the Island. In plaiting, however, the people of New Guinea fall far behind those of the Solomon Islands, many of whose designs executed in differently coloured grasses are real works of art.

The art of carving in wood is practised to a much greater extent among some tribes than among others. In the S.E. of the Island the gable-ends of houses, wall and earth plates, cross-beams, canoes, and almost every tool, weapon, or implement is beautifully carved. In this respect the coast people are before those of the inland tribes, who do not seem to have the same artistic taste.

Cannibalism is not practised universally, but only here and there along the coast, and among the islands. At Orangerie Bay, Cloudy Bay, and near East Cape the people delight in a human dish. At Basilisk, Moresby, and the Islands of the Engineer Group, men, women, and children are still eaten. At Moresby Island I witnessed the boiling of a two-year-old baby, which, together with its mother, had been captured at Basilisk Island. The unfortunate mother had been digested previous to my arrival, and her child soon went the same road. It was tied to a wicker-work frame, and dropped, living, into a large native boiler full of boiling water. There was a smothered cry, a tiny hand and foot quivered for a second, and all was over. Yet, even here, very many of the people did not assist at the feast.

Very many object to the custom, and have never tasted human flesh, or "long meat," as they term it.

The language of the Papuans, it must be borne in mind, comprises a very large number of dialects—every tribe has a different language of its own—and this will give us a great deal of trouble in trying to open up the country. No good of a permanent nature will be possible until we have mastered the dialect of every tribe we come in contact with, and this will take a long time and much study. If properly carried out under an efficient head, the study of the dialectical differences existing between the several tribes should yield results of the highest scientific value. It will be found that a perfect chain exists, and that one dialect has borrowed words from others, which the people using it never heard spoken. At least, this was my experience in New Guinea, where I found certain Motu words in use among the Koiari, Koiari words at Sogore, and Sogore words at Morocca or Havéri.

The custom of "taboo" is practised in nearly all parts of the Island I visited, a small bough stuck in a doorway securing the dwelling and all it contained from interference.

The men at Port Moresby, and inland wherever I went, may be said to go about stark naked. It is simply ridiculous to call a piece of tape half-an-inch wide clothing! Yet a Papuan considers himself naked when without it!

This string or tape—it is as often one as the other—is passed between the legs, and fastened to the belt at the front and back.

The women wear the petticoat, which is *not* made of grass, but of the split leaves of the cocoa or sago palm.

In south-east New Guinea the men wear what might not inaptly be termed short breeches. These are manufactured from pandanus leaves, sewn together, and are ornamented with elaborate patterns. They satisfy even our ideas of decency, and always made me consider these people more advanced than those farther west. Another sure sign of superior civilisation among these people is the practice of prostitution, which obtains at Teste, Moresby, Dinner, and other islands. The women practising it do not seem to lose caste, and they at once become virtuous on marrying. No married woman could attempt such a course of conduct without incurring serious danger; but cases do occur of women leaving their husbands, and running away with a lover. One such came under my notice at Kabadi. The enraged husband collected his friends, and, with their assistance, destroyed all the banana plantations, cocoanut palms, and other things belonging to the destroyer of his domestic happiness. Even his pigs were immolated on the altar of outraged honour. A great feast resulted, as the friends collected the bananas, yams, and betel-nut, and roasted the pigs. This seemed to me a decidedly practical way of punishing the criminal, although the destruction of so many cocoanut palms might have been avoided.

One of the most terrible results of the Queensland slave trade—I use the term advisedly—has been the introduction of syphilis among the inhabitants of Teste Island. Even little girls of ten years were suffering from this terrible scourge when I last visited the Island. The unfortunate savages had no idea of the real nature of this dire malady, but laid the blame on evil spirits.

It was introduced from Mackay or Townsville by the native interpreters of the "Lizzie."

The people of Dédouri blind their pigs with lime to prevent hem from getting into the plantations. Everywhere in New Guinea pigs constitute the most valuable property. They are reared by the women, who may be seen daily suckling their little pets, or feeding them from an earthenware crock. Puppies are similarly reared, and these animals share a mother's milk with her baby. The practice of suckling children into their third and even fourth year prevails.

Wives are bought, the articles given being various, and in quantities suited to the rank of the bride. Shell armlets, tomahawks or stone axes, beads, cocoanuts, and pigs are included in the list. Pearl-shell in the west is the best trade. A man who is blessed with many daughters makes a vast fortune by their sale. Betrothals take place in the south-east at a very early age, and this very often causes serious disagreements.

The girls are nubile long before the young men attain a marriageable age, and object to the delay this causes. These children of nature have no idea of repressing their feelings or desires—hence the trouble.

At Moresby Island the marriage ceremony is very simple. A young woman desirous of marrying invites her sweetheart to her father's house, where he spends the night under her capatilly or mat. Should her father find them sleeping together in the morning when he rises, the marriage is accomplished, and the bridegroom has to pay the price claimed. If, on the other hand, the girl is lying by herself, the bargain is off, and either party at liberty to search for a mate. I asked a girl once why she had rejected a strapping young warrior, who usually went shooting with me, and part of whose "dot" I was willing to pay. Her answer was given with a toss of the head, "Eliam (friend), he is much too heavy"—a curious excuse for breaking off a match.

Betel-nut, which is eaten in large quantities, mixed with lime and pepper-leaf acts as a preventive against the dreadful malarial fevers, so fatal to Europeans. It has also wonderful stimulating properties. When climbing mountains, and completely "winded," I have found myself braced up again in a few minutes after a good chew of betel. A few whiffs inhaled from the Papuan bamboo-pipe has a similar effect.

The Papuans of S.E. New Guinea suffer from a peculiar disease of the scrotum, which I think is closely related to, if not identical with elephantiasis.

At Moresby Island I saw several cases of elephantiasis in men and women. Here also and throughout the Louisiade a peculiar skin disease was very prevalent. Those afflicted with it had the appearance of having been carefully traced all over with elegant arabesques. Desquamation is going on constantly, and shells are used to scrape the body, scratching not giving sufficient relief. I do not doubt that this disease is caused by some sub-cutaneous parasite, not unlike that which is associated with ring-worm. It is not difficult to cure, and generally succumbs to the use of yellow soap and sulphur ointment.

Several cases of phthisis came under my observation during my stay at Moresby Island. The natives seemed quite ignorant of medicine, and nothing was given these unfortunates to relieve them.

Opthalmia also occurs, and this they can cure with almost miraculous rapidity, by simply expressing a couple of drops of the juice of a trailing plant (belonging to the natural order Compositæ) into the eye.

I never came across a deformed Papuan during my travels, and saw only one blind man, who was an object of most tender and affectionate care.

Ulcers are common about Port Moresby and inland, but of rare occurrence among the Islands.

The general method adopted to cure all kinds of diseases is by incantation. Sorcerers therefore do a great trade, and look askance at the white man, who pooh-poohs their power.

These people appear to me far happier in their primitive state than we who boast of our high state of culture. They certainly stand higher than we do in their moral attributes, in fact, they live in a state which I have often heard spoken of as the ideal creation of an enthusiast's phantasy. I cannot do better than close this paper with a quotation from Mr. Wallace's celebrated work, more especially as every word of it is true, and can be proved by others:—"Now it is very remarkable, that among people in a very low state of civilisation, we find some approach to such a perfect social state. I have lived with communities of savages in South America and in the East, who have no laws or law courts but the public opinion of the village freely expressed. Each man scrupulously respects the rights of his fellow, and any infraction of those rights rarely or never takes place. In such a community all are nearly equal. There are none of those wide distinctions of education and ignorance, wealth and poverty, master and servant, which are the product of our civilisation; there is none of that wide-spread division of labour, which, while it increases wealth, produces also conflicting interests; there is not that severe competition and struggle for existence, or for wealth, which the dense population of civilised countries inevitably creates. All incitements to great crimes are thus wanting, and petty ones are repressed partly by the influence of public opinion, but chiefly by that natural sense of justice and of his neighbour's rights, which seems to be, in some degree, inherent in every race of man." That the advent of the white man and his boasted civilisation will tend to degrade the Papuan in the first instance, and to entirely exterminate the race eventually, no one who has studied the history of black *versus* white throughout the world, can doubt. How long will alcohol be kept from them? Or who can stop their being taught to manufacture Kawa from palm juice? And I hold that if spirits are once introduced into New Guinea, disease will surely follow, and disease among a people who are ignorant of medicine means decimation.

Cooktown, 22nd June, 1885.

APPENDIX.

I find that I have unwittingly omitted a few very important customs from my paper, and as I think it would be incomplete without them, I jot them down here as an appendix.

Wherever I landed among the Islands adjacent to South Cape and Milne Bay, I was at first puzzled by the chiefs touching their navel and then pinching the top of their nose gazing at me earnestly the while, and concluding by raising the eyebrows and giving a jerky sort of "huff." I soon discovered that this was to be understood as an inviolable bond of friendship, and whenever I had gone through this ceremony I felt perfectly safe wherever I might be.

Often when enquiring about Duan (Normanby Island), which I was most anxious to explore, Terabiai, the chief of Secco-co-a, in Hoop-iron Bay, assured me that the people of Normanby were his good friends, which he accentuated by going through this pantomime. Farther to the westward this custom is inverted, the nose being touched and then the stomach. Rubbing noses, foreheads, and chins are similarly practised as a form of greeting, answering to our hand shaking. An exchange of names is also much in vogue.

Polygamy is restricted to the chiefs, who have two to five wives at will.

The natives wherever I went seem to honor their parents and hold them in reverent affection.

Mr. J. Chalmers, the well-known missionary and gallant explorer, mentions, *fide* "Matina," a native teacher, that in Aroma a custom prevails of burying old and decrepid relatives, I think this, however, requires confirmation.

The natives hunt the wild pigs regularly, using strong nets which are stretched along the crest of a ridge. Men are stationed at short distances ready to slaughter the animals which are driven by a number of beaters.

This sport is not unattended with danger. At Port Moresby I saw a Kiotapuan whose thigh had been ripped from knee to hip by one slash from a boar's tusk. A pig-catcher is used, consisting of a strong cane ring covered with net.

When a boar charges, which it invariably does, the hunter avoids it by jumping deftly aside, and, at the same time strikes the enraged animal over the snout with the net, which, becoming entangled in the animal's powerful tusks, enables the native to spear or club the boar with comparatively little danger. But it certainly requires great nerve to quietly await such a charge.

The cuscus is also eagerly sought for and eaten, ornaments being prepared from its skin.

The Darnley Islanders used to hang up the bodies of their dead relatives, tap them, and then drink the juices of the putrefying carcass. Now, however, the missionaries of the L.M.S. have altered all this.

The practice of eating or drinking portions of deceased friends is still in vogue in different parts of the Island, more as a proof of affection than from any cannibalistic motive. Cannibalism I believe to be the result of meat-hunger, combined with a disinclination to waste anything edible, and not as is so often affirmed, the prompting of a fierce and bloodthirsty nature.

The people of Moresby Island are cannibals, yet I lived among them and invariably found them gentle, obliging, and affectionate.

At Murray Island the Papuans consider grey hair shameful, and wear wigs to hide the signs of age.

The Rev. James Chalmers in his recently published work on New Guinea[1] expresses his opinion that the coast tribes have driven back the original holders of the littoral inland, being robuster than they.

I cannot coincide with the reverend gentleman's opinion. If this were the case, the coast tribes would scarcely live in such constant dread of the bushmen. They occupy houses built on piles to which their canoes are fastened ready for an emergency. I cannot see any reason for imagining that the inland tribes originally occupied the coast line, we find no legends among

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[1] Life and Adventure in New Guinea. Chalmers and Gill, 1885.

them to lead us into such a belief. They seem capable of driving the coast natives clean off their land in many places, and in others the coast people know nothing whatever about their inland neighbours.

That they are more robust is attributable to the better diet they enjoy. Fish, dugong, shell-fish, holothuria, and turtle are procurable along the whole coast line. It is impossible to overestimate the importance of this fact, and yet the tribes enjoying these advantages are very deficient in courage, and live in constant dread of attack.

Women in the south-east of New Guinea possess inalienable rights—they have their own property in land or valuables. When they marry, they do not forsake their parental roof, but the husband becomes a member of his father-in-law's family. Thus a man blessed with several daughters has a clan on which he can generally rely to assist him in peace or war. The domestic life of the people is simple. A portion of each year is spent at the husband's village—if situated at a distance from his wife's residence—attending to the plantations, bringing in the crops, and in attending to his interests generally. The remainder is spent at the wife's own home. She very rarely condescends to live with her husband's relatives.

Divorce is not unknown, and is effected very simply. Should the wife be to blame, the amount paid for her is refunded, and she is at liberty to marry again. Should the husband be in the wrong, he forfeits all right to compensation. Cases came under my observation, at Teste Island, of women leaving their husbands who were ill, simply because they were weary of nursing them. These were missionary women, and they were pointed out to me by the teacher's wife. A man—also at Teste—divorced his wife for pilfering from her neighbour's plantations. This was a remarkable case, as the girl was one of the comeliest on the Island. Teste Island is the rendezvous of natives from all parts of south-eastern New Guinea and the Louisiade since the missionaries placed teachers on the Island. The Teste men are capital sailors, and were readily engaged by the labour vessels as interpreters. They obtain their canoes from Bute Island, one of the Redlich Group, near St. Aignan, and navigate as far as the Woodlarks in search of pigs, shell-money, and other valuable merchandise. They were cannibals originally, and although they pretend a horror of human flesh, I have seen enough of them when away from their teacher to impress the belief on my mind that they would not hesitate to partake of a cannibalistic feast when or wherever it might offer.

The women throughout New Guinea remove the hair from the pubes, but the men allow it to grow. I think that in the former case it is simply done from a hygienic point of view. Immediately after confinement, or during their menses, women bathe freely in the sea, and do not appear to suffer any ill effect from the practice.

Illegitimate children, as between Papuans, are unknown. Infanticide may account for this, although I cannot say that I succeeded in obtaining any positive information on this subject. The crotons cultivated near every village were pointed out to me as being used to procure abortion.

Cooktown, 18*th July*, 1885.

THE BIRDS OF THE CHINCHILLA DISTRICT.*

BY

KENDAL BROADBENT,

Zoological Collector to the Queensland Museum.

(*Communicated by Henry Tryon, 7th August*, 1885.)

The district, the avifauna of which I have attempted to describe, is situated about 150 miles in a direct line to the W.N.W. of Brisbane, on the banks of the Condamine River; and though the area examined has been necessarily somewhat limited it may be considered typical of a large extent of territory lying immediately to the south and west of it. The Bunya Mountains and the Toowoomba Ranges with their continuation in the Little Liverpool Range, forming a portion of the great Cordillera of Eastern Australia, present a formidable barrier between this and the coast districts, and an obstacle to the assimilation of their bird fauna; whilst the direct communication of this country, by means of the Condamine and Balonne, with the Darling and Murray river areas, and the absence of mountains to the S.S.W. will on the other hand explain the occurrence of birds usually supposed to affect more southern parts, or the possibility of intercepting other birds in the course of their migrations to and fro between the north and south.

This country of Chinchilla is very flat, with a few sandy ridges, and its otherwise uniform surface is only broken by the channels cut by the Condamine and the streams contributing to

* It is due from me to confess my obligations to Mr. H. Tryon for having compiled this paper from notes which were made at his instigation.—K.B.

swell its bulk. The soil is for the most part of a mixed sandy nature, except where patches of black soil occur; and the vegetation is that of a "lightly timbered country," with characteristically dry "brigalow" scrubs of greater or less extent, and open well-grassed pockets here and there. The trees in the timbered country are limited almost entirely to a few species of eucalyptus, but on the edges of the brigalow scrubs are many kinds of small trees and shrubs, such as species of Capparis, Grevillea, Cassuarina, Alstonia, Atalantia, Myoporum, and others, few of which, however, would invite the presence of fruit-eating birds. Amongst the more lowly woody plants several malvaceous genera are represented, and the grasses are both abundant in species and very prolific in seed. Here, as in districts further west, the whole aspect of nature, and especially that due to the element of bird life, is considerably influenced in its presentment by prevailing meteorological conditions; a fact which will explain the occurrence at Chinchilla in seasons differing from those obtaining during my visits, of additional birds to those which I mention. Whilst I was making the observations here given, the weather, on both occasions of my visit, was somewhat dry, with a few heavy showers of short duration. These visits were made to Chinchilla, during the four latter months of 1882 and from April to the end of June of the present year, for the purpose of procuring fossil bones which were known to occur there, and with the secondary object, especially on the latter occasion, of collecting the animals of the district.

The best represented families of birds are:—The family of warblers—Sylviadæ, of which there are eight species; the cuckoo-shrikes—Campephagineæ, of which they are four; the flycatchers represented by five; the thick-head shrikes by five; the crow family by eight; the honey-eaters proper, with what Wallace calls the flower-peckers, by twenty-one; the finches by five; the wood-swallows by four; the kingfishers by four; the parrots by twelve; the pigeons by eight; and the birds of prey by nine.

Examples of almost all the 140 birds included in the following enumeration have been shot by me, and except in the case of a few critical species I have little doubt concerning the accuracy of the determinations given in the following census:—

Aquila audax, *Lath.* The "Eaglehawk."

Falco lunulatus, *Lath.* The White-fronted Falcon.

Hieracidea berigora, *Vig. and Hors.* The Brown Hawk, seen in October.

Tinnunculus cenchroides, *Vig. and Hors.* The "Kestrel."

Accipiter cirrhocephalus, *Vieill.*

A. torquatus, The "Sparrow Hawk."

Milvus affinis, *Gould.* The "Kite."

Elanus scriptus, *Gould.* The Letter-winged Kite.

Ninox strenua, *Gould.* The Great Owl of the Brushes.

There were a pair of these large owls which frequented the neighbourhood of my camp, especially when the nights were darkest. They uttered a cry of *more-pork*, but the sound was deeper and more voluminous than that used by the boobook owl. The male bird when shot had an opossum, of which the head had been eaten off, in its claws.

Ninox boobook, *Lath.* The Boobook Owl.

Œgotheles Novæ-hollandiæ, *Vig. and Hors.*

Podargus strigoides, *Lath.* The Tawny-shouldered Podargus.

Chætura caudacuta, *Lath.* The Spine-tailed Swift.

Hirundo frontalis, *Quoy and Gaim.* The Welcome Swallow.

The first of these birds which I noticed, on its northward journey, was in the middle of May, and I did not meet with this swallow again until 12th June.

Lagenoplastes ariel, *Gould.* The Fairy Martin.

Merops ornatus, *Lath.* The Bee-eater, was here in the fall of the year.

Eurystomus pacificus, *Lath.* The Dollar Bird, which I obtained here in December. These birds remain in the locality as far as I have observed until February.

Dacelo gigas, *Bood.* The Laughing Jackass.

Halcyon sanctus, *Vig. and Horsf.* The Sacred Kingfisher.

Halcyon Macleayi, *Jar. and Selb.* Macleay's Kingfisher.

Alcyone azurea, *Lath.*

Artamus sordidus. I observed this Wood Swallow (for the first time on the 6th June) on its northward migration.

Artamus minor, *Vieilloh.* The Little Wood Swallow, which left here during the middle of April.

Artamus personatus, *Gould.* The Masked Wood Swallow; is here during the summer months.

Artamus superciliosus, *Gould.* The White-eyebrowed Wood Swallow; is here during the summer months, and remains until May. I saw one on 11th May.

Pardalotus punctatus, *Temm.* The Spotted Diamond Bird; is rather a scarce species at Chinchilla, as far as my experience goes.

Pardalotus striatus, *Vig. and Horsf.* The Striated Diamond Bird.

I have included under this specific name four specimens—three females and a male. They are evidently the local representatives of this species from which they differ in having the first and third primaries only, instead of the whole number, edged with white. The speculum in each example is uniform scarlet coloured. What is the range of this race has yet to be determined.

Pardalotus assimilis, *Ramsay.*

A further example of this section of the diamond birds may be with some doubt referred to this species. It has the third and fourth primaries as well as the first, edged with white, and a reddish-yellow speculum.

Pardalotus melanocephulus, *Gld.* The Black-headed Diamond Bird.

Strepera graculina, *White.* The Pied Crow-shrike.

Strepera anaphonensis, *Tem.* The Grey Crow-shrike.

Gymnorhina tibicen, *Lath.* The Piping Crow-shrike.

Cracticus robustus, *Lath.*

C nigrogularis, *Gld.* The Black-throated Crow-shrike.

C. torquatus, *Lath.*

C. destructor, *Temm.*

Grallina picata, *Lath.* The Magpie Lark.

Graucalus melanops, *Lath.*

Graucalus mentalis, *Vig. and Horsf.*

Campephaga humeralis, *Gould.* The White-shouldered Campephaga; found here in September, being a migratory bird in these parts.

Pachycephala gutturalis, *Lath.* The White-throated Thickhead.

Pachycephala rufiventris, *Lath.* The Rufus-breasted Thickhead.

Colluricincla harmonica, *Lath.* The Harmonious Shrike-thrush.

Falcunculus frontatus, *Lath.* The Shrike-tit.

Oreoica cristata, *Lewin.* The Crested Oreoica.

Chibia bracteata, *Gould.* The Drongo-shrike; which is not a stationary denizen of this district.

Rhipidura albiscapa, *Gould.* The White-shafted Fantail; is probably here throughout the year.

Sauloprocta motacilloides, *Vig. and Horsf.* The Black Fantail.

Seisura inquieta, *Lath.* The Shepherd's Companion.

Miagra plumbea, *Vig. and Horsf.* The Leaden-coloured Fly-catcher. I noticed here in April, it flies further north as winter comes on.

Micræca fascinans, *Lath.* The Brown Fly-catcher.

Gerygone albogularis, *Gould.* The White-throated Gerygone.

Gerygone fusca, *Gould.* The Brown Gerygone.

I have referred to this species, a sprightly little bird which frequents the tall gum trees, in the top-most branches of which it is ever busy in its quest for insects. It has the bill and legs black, and the eyes brown. I shot one example on the 13th of May.

Smicrornis brevirostris, *Gould.*

S. flavescens, *Gould.*

Petrœca goodenovii, *Vig. and Horsf.* The Red-capped Robin. As scarce in this as in the coastal districts of the colony.

Melanodryas cuculata, *Lath.* The Hooded Robin.

Eopsaltria australis, *Lath.* The Yellow-breasted Robin; a common bird in the southern colonies where it also breeds.

Malurus cyaneus, *Lath.* The Blue Wren.

Malurus lamberti, *Vig. and Horsf.* Lambert's Blue Wren.

Malurus melanocephalus, *Vig. and Horsf.*

Acanthiza uropygialis, *Gould.* The chestnut-rumped Acanthiza.

This bird is to be met with in this locality throughout the winter and summer months. It is one of the rarest of the Acanthizas, and this western country appears to be its true habitat. It is a very active little bird, creeping through the thick bushes on the edge of the scrubs in quest of insect food. Its habits and general appearance render it difficult to procure.

Geobasileus chrysorrhous, *Quoy and Gaim.*

Chthonicola sagittata, *Lath.*

Anthus australis, *Vig. and Horsf.* The Australian Pipit.

Sphenœcus galectotes, *Temm.* The Larger Grass Bird.

Stictoptera Bichenovii, *Vig. and Horsf.* The Double-barred Finch. I found a nest of this bird containing young ones, 11th May, 1885.

Œgintha temporalis, *Lath.* The Red-eye.

Aidemosyne modesta, *Gould.* The Plain-coloured Finch.

Stagenopleura guttata, *Shaw.* The Spotted Finch.

Pœphila cincta, *Gould.* The Banded Finch.

Chlamydodera maculata, *Gould.* The Spotted Bower Bird.

Mimeta viridis, *Lath.* The Green Oriole, which is tolerably plentiful here in April.

Corcorax melanorhamphus, *Vieill.* The White-winged Chough.

Struthidea cinerea, *Gould.* The Grey Struthidea.

Corvus australis, *Gmel.*

Pomatostomus temporalis, *Vig. and Horsf.*

Pomatostomus superciliosus, *Vig. and Horsf.*

Ptilotis lewinii, *Swains.* Swainson's Honey-eater.

Ptilotis plumula, *Gould.* The Plumed Ptilotis.

Ptilotis penicillata, *Gould.* The White-plumed Honey-eater.

Ptilotis chrysops, *Lath.*

Plectorhyncha lanceolata, *Gould.*

Meliphaga phrygia, *Lath.* The Warty-faced Honey-eater.

I met with a small flock of these birds, which I have never before seen in Queensland, on 7th July. Mr. E. P. Ramsay, F.R.S., however, records their occurrence in the Wide Bay and Rockingham Bay Districts. [Proc. Lin. Soc., N.S.W., Vol. II., pg. 189].

Acanthogenys rufogularis, *Gould.* The Spiny-cheeked Honey-eater. A bird confined to the interior of Australia, and, as far as I am aware, not met with previously so far north.

Philemon corniculatus, *Lath.* The Common Leather-head.

Philemon *sp.*

I obtained three specimens (one male and two females) which had the yellow colouration of the breast, which is said to be characteristic of the immature birds of the above species. They, however, altogether exceeded the measurements of the seven examples of P. corniculatus which I secured. Moreover, I had no reason, at the time of skinning them, to consider the birds otherwise than adult.

Philemon citreo-gularis, *Gould.*

Entomyza cyanotis, *Swainson.* The Blue-faced Honey-eater.

Melithreptus brevirostris, *Vig. and Hors.* [Trans. Lin. Soc. XV., p. 315].

Melithreptus gularis, *Gould.*

Melithreptus albogularis, *Gould.*

Myzantha garrula, *Lath.* The "Common Minah" of the colonists.

Dicæum hirundinaceum, *Shaw.*

Zosterops cærulescens, *Lath.* The Grey-backed White-eye.

Zosterops, *sp.*

Climacteris scandens, *Temm.* The Brown Tree-creeper.

Climacteris lencophæa, *Lath.*

Sitella leucocephala, *Gould.* The White-headed Sitella.

Amongst all the birds of this species which I observed, and in those which I shot (3 males and 1 female), I did not remark a single example with the conspicuously white head, which is noticeable in these birds—especially the old cocks—which frequent the coast districts. In fact, the heads of the Chinchilla Sitellas could only be styled white in a qualified sense. I also noticed that the female bird was possessed with a shorter and stouter bill than the male.

Cacomantis pallida, *Lath.* The Unadorned Cuckoo; I observed here in the summer of 1882, but no Cuckoos winter in the district.

Cacatua galerita, *Lath.* The Sulphur-crested Cockatoo. Here, as everywhere else in Australia, and represented by a large-sized race.

Calyptorhynchus Solandri, *Temm.* (*C. Leachii*, Kuhl.)

Calyptorhynchus funereus, *Shaw.*

Aprosmictus scapulatus, *Bechst.* King's Parrot.

Aprosmictus (Ptistes) erythropterus, *Gould.* The "Red Shoulder."

Platycercus pallidiceps, *Vig.*

Euphema elegans, *Gould.* The beautiful Ground Parroquet.

Lathamus discolor, *Gould.* The Swift Lorikeet.

I have never before met with this bird so far north, but it is common enough in Victoria, being found accompanying Trichoglossus pusillus, *Shaw*, and other birds of associated habits, and feeding on the honey of the various eucalypti.

Trichoglossus multicolor, *Gmel.* The "Blue Mountain."

Trichoglossus chlorlepidotus, *Kuhl.* The Scaly-breasted Lorikeet.

Trichoglossus pusillus, *Shaw.* The Little Lorikeet.

Chalcophaps chrysochlora, *Wagl.* The Little Green Pigeon. A scarce bird here.

Leucosarcia picata, *Lath.* The Wonga Pigeon.

Phaps chalcoptera, *Lath.* The Bronze Wing.

Geophaps scripta, *Temm.* The Squatter Pigeon.

Lophophaps plumifera, *Gld.* The Plumed Bronze Wing.

My observations would lead me to infer that this is a rare bird in the district, as I only met with a single specimen. This was on the dry sandy ridges, and in the middle of summer.

Erythrauchæna humeralis, *Bonp.* The Barred-shouldered Dove.

Geopelia tranquilla, *Gould.* The Peaceful Dove.

Geopelia (Stictophelia) cuneata, *Lath.* An uncommon bird in the Chinchilla country.

Talegallus Lathami, *Gray.* The Scrub Turkey.

Synoïcus australis, *Lath.* The Swamp Quail.

Dromaius Novæ-Hollandiæ, *Lath.* The Emu.

Chloriotis australis, *Gray.* The Plain Turkey.

Ædicnemus grallarius, *Lath.* The "Thick Knee" or Night Plover.

Lobivanellus lobatus, *Lath.* The Spurred-Winged or Wattled Plover.

Ægialitis nigrifrons, *Cuv.* The Dotterell.

Threskiornis strictipennis, *Gould.* The White Ibis.

Geronticus spinicollis, *Jameson.* The Straw-necked Ibis.

Grus australasianus, *Gould.* The Native Companion.

Ardea pacifica, *Lath.*

Ardea Novæ-hollandiæ, *Lath.* The Blue Crane.

Nycticorax caledonicus, *Lath.* The Nankeen Heron.

Chlamydochen jubata, *Lath.* The Wood Duck.

Anas superciliosus, *Gmel.* The Grey Duck.

Nyroca australis, *Gould.* The White-eyed Duck.

Pelecanus conspicillatus, *Temm.* The Pelican.

Graculus stictocephalus, *Bon.* The Little Black Shag.

Graculus leucogaster, *Gould.* The White-bellied Shag.

Plotus novæ-hollandiæ, *Gould.* The Snake Bird.
Podiceps australis, *Gould.* The Dab Chick.

FRIDAY, SEPTEMBER 4, 1885.

In the Presence of His Excellency Sir Anthony Musgrave, K.C.M.G., Patron of the Society; A. Norton, Esq. M.L.A., Vice-President, in the Chair.

Mr. Clement L. Wragge, of the Ben Nevis Observatory, was introduced as a visitor.

NEW MEMBERS.

Alexander Corrie, Esq., Brisbane; J. Hamilton, Esq., M.L.A.; E. Mansfield, Esq., Brisbane; D. Mapleston, Esq., Brisbane; B. D. Morehead, Esq., M.L.A.; W. Kinnaird Rose, Esq., Brisbane; H. H. A. Russell, Esq., Milton; C. J. Stevens, Esq., M.L.A.; J. Stevenson, Esq., M.L.A.; and J. Thomson, Esq., M.B., etc.

DONATIONS ANNOUNCED.

"Proceedings of the Geographical Society of Australasia," Vol. I. Sydney, 1885. From the Society.

"Victorian Naturalist," Vol. II., No. 4. Melbourne, 1885. From the Field Naturalists' Club of Victoria.

"Nineteenth Annual Report on the Colonial Museum and Laboratory, &c." Wellington, 1885. From the Director, Colonial Museum and Geological Survey of New Zealand.

"Transactions and Proceedings of the Royal Society of Victoria," Vol. XXI. Melbourne, 1885. From the Society.

"Journal of the Royal Society of New South Wales," Vol. XVIII. Sydney, 1885. From the Society.

"Report of Progress," 1882-83-84. Montreal, 1885. "Maps o accompany Report of Progress, 1882-83-84"; and "Catalogue of Canadian Plants, Part II, Gamopetalæ," by John Macoun, M.A., F.L.S. Montreal, 1884. From the Director, Geological and Natural History Survey of Canada.

"The Australian Irrigationist," No 13. Melbourne, 1885. From the Editor.

The following papers were read:—

"THE PAPUANS—COMPARATIVE NOTES ON VARIOUS AUTHORITIES WITH ORIGINAL OBSERVATIONS," by William E. Armit, F.L.S., F.R.G.S., Pages 95-116.

A SHORT ACCOUNT OF THE MEASUREMENT OF THE BASE LINE IN CONNECTION WITH THE TRIGONOMETRICAL SURVEY OF QUEENSLAND.

BY

W. A. TULLY, ESQ., B.A., F.R.G.S., &c., SURVEYOR GENERAL.

(PLATE V.)

I propose giving a short account of the measurement of the base-line in connection with the Trigonometrical Survey of the Colony, which was completed last year.

A base-line is the foundation of a trigonometrical survey. On the accuracy of its measurement depends the correctness of the net-work of triangles, which are established by angular measurements, commencing from the terminal points of the base. The exact measurement of a line on the earth's surface is one of the most difficult operations that can be undertaken. Even with the greatest care and the most approved appliances only a close approximation to absolute accuracy can be relied on. Experience proves that no two measurements of the same line exactly agree; there is always a small difference, and though such difference may be inconsiderable, and even unappreciable, what is styled "mathematical accuracy" cannot be attained. The earlier measurements in such surveys were conducted under circumstances less favourable to accuracy than those obtaining at the present day. We have now the experience gained by each successive survey, the history of which has been carefully recorded. It would take too long to give particulars of the several bases that have been measured successfully, although much interesting matter would be found in their recital.

The chief difficulty is obtaining a *unit* of *length*, by means of which the measurement is made. Almost all substances, metallic or otherwise, expand and contract with heat and cold: so that it will be understood in determining the length of any line when measured by means of a rod, or chain, made of a material liable to fluctuation, it is necessary to know what its absolute length is at some known temperature. This temperature is usually fixed at about 62° Fahrenheit. The standard of the Ordnance Survey in Great Britain is ten feet in length, and one of the same length was used in this Colony. This length is nominal, and is only correct when the temperature is 64°2. The details of the methods used for determining the length of a standard would provide material for a separate paper, and I shall only refer to the subject by mentioning that the comparisons of standards often occupy months, and the greatest care is taken that the thermometers and micrometers used are of the best workmanship. At the Ordnance Survey Office, Southampton, is a building specially constructed for the purpose. The inner room, where the comparisons are made, measures twenty feet by eleven, with thick double walls, and is sunk below the level of the ground, and roofed with nine inches of concrete. An outer building entirely encloses and protects the room from external changes of temperature. This will give an idea of the accuracy aimed at in these comparisons. Each division of the micrometer microscopes used is about one-millionth of a yard.

The determination of the temperature is of the utmost importance. The thermometers used require to be accurately graduated, and their index errors ascertained by careful comparisons with a standard thermometer. The co-efficient for expansion is the same as that used for steel bars, and amounts to ·007632 inches in one hundred feet for one degree of temperature. This co-efficient is the one invariably adopted, and has been tested many times by the most careful experiments. The standard of our Queensland Survey is a bar of steel, floating in mercury, the length of which was determined by careful comparisons with the standard bars in the Sydney Observatory, which have been supplied by the Board of Trade in London. This bar has a length of 9·9998581 feet, at a temperature of 62° Fahrenheit; so that, applying the above co-efficient for expansion of steel, its length at any other temperature can be determined.

Having been provided with a standard, it was necessary to decide how the base should be measured. Having given the subject careful consideration, I determined to use a steel tape of one hundred feet in length, with such appliances as would ensure a high degree of accuracy. The experience subsequently gained in the measurement proves that I was right, as it is now clearly established that, with proper care, a base-line can be measured with equal accuracy with a one hundred-foot tape as with bars of shorter length. The next step was how to ascertain the length of the tape with reference to the bar. The necessity for doing this had not arisen before, as most of the base-lines had been measured with wooden or steel rods ten feet in length. I was fortunate enough in having Mr. Adams, the Surveyor-General of New South Wales, and Mr. Russell, the Government Astronomer of that Colony to assist me, and between them they devised an apparatus, by means of which a tape of one hundred or sixty-six feet can be compared with the standard bar, and its length accurately determined. The result of the several comparisons, and the temperatures at which they are taken are given in the Appendix A. It will be seen that two tapes (A and B) were used in the measurement of the base, and the length adopted for each tape was the mean of twelve comparisons taken at different times. The apparatus referred to is similar to those used for comparing bars of assumed equal lengths. It has micrometer microscopes attached by which the smallest differences between the bar and each tenth part of the tape, with which the comparison is made, can be determined. The temperature is observed by means of the best thermometers, the index errors of which are known.

The base line is situated on the open plain known as the prairie plain, between Mount Irving and Mount Maria, the summits of which are the terminal points. The former mount is about 215·8 feet, and the latter 162·5 feet above the level of the plain. The principal reason for selecting Mounts Irving and Maria, as terminal points of the base, were that observations could be made more accurately from their summits than from the terminals on the plain, where the atmospheric conditions were less favourable for the use of telescopes of high magnifying power. At first it was decided that the base should be confined to the plain, on the line extending from one summit to the other—the length of the sections at each end of the base being computed by triangulation. When the measurement commenced it was proved to my satisfaction that the terminal sections could be measured without risk of error. The ascent to the summit of Mount Maria is a gradual slope, so that no difficulty was experienced there. Mount Irving is rocky and more abrupt, necessitating a track being cleared and levelled In the case of the latter section the measurement was carried out three times—two of them in opposite directions. The length was also computed by means of triangulation, as a check upon the work. The plain was, moreover, very suitable for the operation in so much that it was surrounded by hills, which permitted of stations being readily obtained for extending the triangulation.

All the preparations having been made, and the plant brought to the ground, the measurement was commenced on August 24th, 1883, under the superintendence of Mr. District Surveyor McDowall, assisted by Mr. R. Hoggan. The base was divided into ten sections: the six central ones averaging nearly a mile, and the two others at each end being nearly half-a-mile long. The terminal points of these sections were marked by stones sunk into the ground and set in concrete. Each stone had a metal plug, upon which a small mark was made denoting the terminal point of the section. The tapes used on the survey were about half-an-inch wide, and little more than a hundredth of an inch thick. The one hundred feet lengths are denoted by minute dots, or spots, on silver discs, which were inserted in the tapes, about six inches from each extremity. The method adopted was as follows:—the tapes A and B were laid side by side in the troughs. These troughs were made of Kauri Pine (Dammara robusta), one inch thick, which being a light wood and a good non-conductor of heat was found well-suited for the purpose. Each trough was about fifteen feet in length, so that they could be easily carried; and whilst the measurement was being carried on with one hundred feet, the troughing for the next one hundred feet was being placed in position. There was some difficulty at the outset in devising suitable covers for the troughing—so as to shade the tapes from the direct rays of the sun. A strip of blanket was used at first, but was not found to answer. After some trials, a board, sufficiently wide to shade the bottom of the trough, whilst allowing for ventilation, was used, with the best results. Our subsequent experience proved the boards to be reliable in every way. The troughs were supported upon pegs set on an even grade by means of a levelling instrument. Each sub-division of one hundred feet was marked by a piece of sawn hardwood, 4 x 4 inches, and three feet long, strongly driven into the ground. On the top of the peg a small copper stud, with a flat disc (a copper rivet was used for the purpose) was inserted to receive the mark at the end of each hundred feet. Three measurements were made with each tape, each one distinct and independent, so that every section has been measured six times. A tension of 20 lbs., by means of a spring balance, was applied to each tape. The following extract from the instructions issued for the guidance of the surveyors employed in the measurement will supply the particulars in regard to the microscopes used. I have brought down similar ones for the inspection of members :—

"Two microscopes are to be used—one at each end of the tape. The 'following' one is for the purpose of keeping the end of the tape and the mark previously made on the copper stud co-incident, whilst, by means of the 'leading' microscope, a mark is made on the copper stud, as nearly as possible agreeing with the terminal point of the steel tape. The 'following' microscope being set to zero, the 'leading' one is used for the purpose of comparing the mark made on the copper stud with the terminal point of the tape in each measurement, and registering the micrometer value of the interval—if any—between them. The micrometer microscopes used have a value represented by two revolutions of the screw to one hundredth of an inch; and with the view of lessening the risk of error by recording *plus* and *minus* readings in the field book, the reading of the 'leading' micrometer is assumed to be twenty revolutions at zero; so that all readings above twenty are *plus*, and all below *minus*. It will be observed that the reading is from the point marked on the stud to the terminal point on the tape—the measurement from a fixed point to one liable to fluctuation by temperature, being more reliable than were the measurement taken in the reverse way."

Immediately after each measurement was made and recorded, readings were taken from five standard thermometers which were placed alongside of the tapes at equal distances, fifteen readings were therefore taken during the three measurements of each tape. The mean of these readings must approximate very closely to the true temperature. The thermometers used were very carefully compared with a standard which was procured from the observatory in Sydney, and the index errors determined. It is not probable that the temperature adopted is more than one-fifth of a degree Fahrenheit in error, but even were it in error half a degree it would not affect the length of the base by more than 1·3 inches.*

The principal advantage of the system adopted, apart from the greater speed with which the measurement could be carried out, was the means it provided for checking the work as it proceeded. In consequence of the length of the tape its fluctuations as the temperature altered were quite appreciable. I recollect when working at one of the microscopes seeing the tape visibly contract as a cold blast of air entered the troughs. It was often observed that the tape was more sensitive than the thermometers, and we often had to wait until the latter had settled down to the temperature of the tape. The co-efficient for ex-

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*After the base line had been measured six thermometers were supplied from the Royal Observatory, Kew, England, in response to the following special application made to G. M. Whipple, Esq., Superintendent:—

"QUEENSLAND.
"SURVEYOR-GENERAL'S OFFICE,
"BRISBANE, *22nd Jan.*, 1884.

"SIR,—I trust I am not trespassing on your kindness in asking you to assist me in procuring a set of thermometers for the use of this department, in connection with the measurement of base lines in the field.

"I am anxious to have 12 thermometers sent to me of a class suitable for recording the temperature in such measurements where great accuracy is required. It is found, by experience, in sudden changes of temperature, that the steel tapes are more sensitive than ordinary standard glass thermometers; and it is possible that some modification pansion was as before stated ·007632 inches for each degree of the thermometer, so that it was easy to determine whether any excess or deficiency in the length of the tape agreed with the micrometer. The corrections from one to six degrees are as follow:—

1°	·00763 inches.	4°	·03052 inches.
2°	·01526 „	5°	·03815 „
3°	·02289 „	6°	·04578 „

One to eight revolutions of the micrometer represent the following fractional parts of an inch, viz.:—

1 revolution.	·005 inches.	5 revolutions.	·025 inches.
2 „	·010 „	6 „	·030 „
3 „	·015 „	7 „	·035 „
4 „	·020 „	8 „	·040 „

It will be seen by a comparison of these values that three revolutions of the micrometer nearly equal the correction for two degrees of temperature, whilst the expansion or contraction for five degrees of temperature nearly equals eight revolutions of the micrometer. The relative values of the micrometer

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of the clinical thermometer might be devised to answer the purpose. What is required is sensitiveness, combined with stability of construction. It will be understood that very delicate glass thermometers are so liable to break that they are practically worthless in field use.

"The thermometers should be graduated to 0·2 of a degree, and should range from 32 to 125 degrees. I enclose a letter from Mr. Cassella, who appears to have given the subject some consideration. You might, at your convenience, arrange to see him and ascertain whether he has anything to suit my wants. Any expense will be met as soon as you advise me.

"You will excuse my troubling you in this matter. I wish to have the most suitable class of instruments that can be procured, and I believe you can assist me better than anyone else.

"I have the honor to be, Sir,

"Your obedient servant,

"(Signed) W. ALCOCK TULLY,

"Surveyor-General.

"G. M. Whipple, Esq.,

"Superintendent Royal Observatory,

"Kew, England."

measurements and the corrections for temperature were readily borne in mind, and, whilst the measurement was being carried out afforded a most efficient check, any divergence being at once noticed, and as it indicated that the thermic conditions of the tape and the thermometers did not agree, one or more additional measurements were taken until the opposing differences were reconciled. Whilst the temperature was steady the micrometers and thermometers worked together most harmoniously—rapid fluctuations on the contrary produced conflicting readings. The advantage of having such a check cannot be over-rated. It gave an additional value to the work. The confidence which it engendered reacted on the observers and enabled them to give a more undivided attention to the details than was possible under other circumstances.

I give in appendix B the computed lengths of each separate measurement and the difference between the mean of each section. The difference between the mean of the three measurements of each tape was ·1845144 inches, which is not quite $\frac{2}{10}$ of an inch. The adopted lengths of the tapes were as follow:—

Tape A	- - -	99·9980561 feet
Tape B	- - -	99·9976211 ,,
Difference	- -	·0004350 ,,

This fractional part of a foot is nearly equivalent to $\frac{1}{200}$ of an inch. This difference in length between the two tapes, were it constant throughout the entire distance from end to end of the base, would have amounted to 1·8 inches; but as the actual difference between the measurement by each tape was not quite $\frac{2}{10}$ of an inch, it proves that about an inch and a half of the theoretic difference was absorbed by errors of observation or other counterbalancing cause. The measurement by each tape has equal weight, and the mean of the two is only affected by the above absorption to the extent of ·7 of an inch. The above values in dealing with a base exceeding seven miles in length are so small that it is scarcely necessary to take account of them, and I only refer to them in this paper to show how the difference in the computed lengths of the tapes was disposed of. In order further to test the accuracy of the measurement of the whole line, a system of triangles was established by which the length of half the line was computed and compared with the measured length of the same portion. The differences between the computed and measured length of the half was found to be only ·936 of an inch, which is a most satisfactory proof of the care exercised in the measurement as well as of the system adopted in carrying it out.

The line was measured, as before stated, in grades from peg to peg in 100 feet lengths. These lengths represented the hypothenuse of a right-angled triangle of which the side next in length represented the actual horizontal length between the pegs. A reduction of the measured length to the horizontal had to be made and computed for each subdivision. The correction, unless for the two terminal sections, was very small. The measured length being the hypothenuse, and the rise or fall between the pegs, as the case may be, being the smallest side of the triangle, it was easy to find the third side. For convenience of calculation the difference of the squares of these two sides was found by the well-known formula of multiplying the sum and difference of the sides, and then extracting the square root of the product. This gave the horizontal length. The total correction for reduction to the horizontal was 31·123 feet, of which 19·732 feet was for the Mt. Irving section, and 11·225 feet for that of the Mt. Maria end.

The base was computed by logarithms, so that each stage of the process, from the entry in the field notes to the final determinations, could be traced step by step. It was a more laborious process than the ordinary arithmetical way, but it has the advantage of showing every detail of the calculation, and has necessarily greater weight than if the base were calculated in the other way.

[At this stage the author exhibited, for the information of members, a book in which the results of the computations had been entered, and also some other papers relating to the subject.]

The base line being measured on a plain with an average height of 1298 feet above the sea level had to be reduced to that level. This reduction was effected by the formula:—"Multiply together the base and height, and divide the product by the radius of the earth, and the quotient will be the correction to be deducted from the base." This correction amounted to 2·2520 feet which had to be subtracted from the measured length.

The probable sources of error were also investigated. None of them were likely to affect the accuracy of the work, and as they would not act in the same direction, the result would be according to the law of compensation that one would tend to counteract the others.

The whole work depends on the correctness of value given to the standard bar used on the survey. It will be understood that a very small error in the length of the bar will more than overbalance all other errors that can arise.

The several sources of error are as follow:—

1. Error in determining correct temperature.

2. The co-efficient used for expansion not being applicable to the steel of which the tapes were composed.

3. The liability of the tapes being out of line. It may be mentioned that a declination of one inch out of the line in three places throughout the whole base will give a possible error of ·64 inches. A declination of one inch from the straight line in the middle of each tape would produce an error of 0·05 inches in the whole base.

4. Frictional error by affecting the tension.

5. Errors in micrometers. This would necessarily be very small, if any, as the micrometers are only responsible for the measurement of 1·018 inches of the whole base.

The extreme error possible under any of the above—Nos. 1 and 2—would not exceed an inch, and in the others it would amount to a very small fraction. Having given the question careful consideration it was determined not to make any allowance for these small errors.

I have endeavoured to give a general idea of the details of the measurement, avoiding as far as possible technicalities which would only be understood by the profession. As a rule the general public take little interest in the execution of these surveys. They may acknowledge them to be necessary, but do not care to know the processes by which they are carried out. I am glad of the opportunity the Royal Society has afforded me of placing the results of the measurement on record, and trust I have succeeded in interesting the members whilst dealing with a somewhat dry subject:—

APPENDIX A.

Determination of the Length of Tapes A and B used in Measurement of Base Line.

100FT. APPROX.—TAPE A.			100FT. APPROX.—TAPE B.			Tension, 20 lbs.
Date of Measurement.	Temperature.	Length at 62deg. Faht.	Date of Measurement.	Temperature.	Length at 62deg. Faht.	
1883.		FEET.	1883.		FEET.	
Sep. 14	66·5	99·9977453	Sep. 14	67·9	99·9969864	
„ 15	66·0	99·9978127	„ 15	66·5	99·9970344	
Nov. 7	72·5	99·9983970	Nov. 8	72·0	99·9977527	
„ 7	73·0	99·9980835	„ 8	73·5	99·9974246	
„ 7	73·5	99·9980573	„ 8	73·5	99·9975248	
1884.			1884.			
May 16	61·0	99·9975325	May 16	63·0	99·9976441	
„ 17	61·0	99·9975197	„ 17	62·5	99·9978327	
Aug. 8	64·0	99·9982328	Aug. 7	64·0	99·9973815	
„ 8	64·5	99·9985049	„ 7	65·0	99·9980631	
„ 9	63·5	99·9986753	„ 9	64·5	99·9985667	
Nov. 1	72·0	99·9968217	Nov. 1	74·0	99·9976355	
„ 3	72·0	99·9964533				
Adopted mean -		99·9980561	Adopted mean -		99.9976211	

APPENDIX B.

MEASUREMENT OF ENTIRE LENGTH OF BASE LINE (FROM SUMMIT OF MT. IRVING TO SUMMIT OF MT. MARIA).—TABULAR RESULTS IN FEET.

		Deg.	A1.	A2.	A3.	Mean A.	Difference of Means.	Mean B.	B1.	B2.	B3.
1884.	Mt.										
Sep.-Oct. ...	Irving.	70	2546·4099339	2546·4160688	2546·4153823	2546·4137919	0·0039618	2546·4098331	2546·4103215	2546·4096699	2546·4095079
Sep.	1	73	2499·9667170	2499·9666739	2499·9672573	2499·9668827	0·0088902	2499·9757729	2499·9759511	2499·9768418	2499·9745260
1883.											
Aug. 31-Sep. 7	2	71	4700·1733328	4700·1717090	4700·1725780	4700·1725399	0·0014832	4700·1740231	4700·1774686	4700·1721419	4700·1724595
Sep. 9-Sep. 25	3	78	4000·3494483	4000·3464889	4000·3468172	4000·3475850	0·0043652	4000·3519502	4000·3523487	4000·3506108	4000·3528908
Sep. 25-Oct. 2	4	75	5000·2951300	5000·2961735	5000 2939590	5000·2950878	0·0015760	5000·2935118	5000·2956193	5000.2925837	5000·2923332
Oct. 2-Oct. 6	5	74	4500·2447470	4500·2432462	4500·2420932	4500·2433621	0·0167685	4500·2265936	4500·2277747	4500·2267747	4500·2252314
Oct. 8-Oct. 11	6	76	4500·3290552	4500 3325728	4500·3318397	4500·3311559	0·0030507	4500·3281052	4500·3275099	4500·3288525	4500·3279529
Oct. 12-Oct. 19	7	79	5000·4716607	5000·4725609	5000·4745378	5000·4729201	0·0036514	5000·4692687	5000·4685280	5000·4709806	5000·4682975
Oct. 19-Oct. 22	8	84	2000·0939146	2000·0957883	2000·0963933	2000·0953638	0·0001460	2000 0952178	2000·0951609	2000·0949132	2000·0955782
Oct. 22-Oct. 24	9	89	2281·4195725	2281·4209571	2281·4229186	2281·4211496	0·0046472	2281·4257968	2281·4256613	2281·4260411	2281·4256882
			37029·7535120	37029·7622394	37029·7637764	37029·7598418	0·0097686	37029 7500732	37029·7563440	37029·7494102	37029·7444566

Mean - - 37029·7549575.

FRIDAY, OCTOBER 2, 1885.

THE VICE-PRESIDENT, A. NORTON, ESQ., M.L.A., IN THE CHAIR.

Dr. Ledingham was introduced as a visitor.

NEW MEMBERS.

C. Campbell, Esq., As. Inst., C.E., and E. Heaviside, Esq., Mining Engineer, Ipswich.

A revised code of rules, the preparation of which had lately engaged the attention of the council, was adopted, on the motion of Mr. R. C. Ringrose, who explained the natuie of the emendations which it contained.

DONATIONS.

"The Journal of Conchology," Vol. IV., No. 11. July, 1885. From the Conchological Society of Great Britain.

"The Victorian Naturalist," Vol. XI., No. 5. September. 1885. From the Field Naturalist's Club of Victoria.

"Systematic Census of Australian Plants," by Baron Von Mueller, K.C.M.G., M. & Ph. D., F.R.S. From the Author.

"Abstract of Proceedings," Sept. 7th, 1885. From the Royal Society of Tasmania.

"The Provincial Medical Journal," Vol. IV., No. 44. Aug., 1885. From the Editor, Leicester.

"Journal of the Straits Branch of the Royal Asiatic Society," Nos. 1-12. Singapore, 1878-85. From the Society.

Report of meeting of "Natural History Society." ["*Morning Bulletin*," Rockhampton, 15th Sep., 1885.] From the Society.

"Proceedings of the American Academy of Arts and Sciences." New Series, Vol. XII. Boston, 1885. From the Academy.

"The Australian Irrigationist," No. 14. Melbourne, 1885. From the Editor.

"Report of the Board of Trustees of the Queensland Museum for 1884." Brisbane. From the Curator.

"Map showing the site of Melbourne in 1837." From the Public Library, Melbourne.

The following papers were read :—

PRACTICAL HYBRIDIZATION,

BY

JAMES PINK, Esq., F.R.H.S.

In this paper the author remarked generally on the important practical results consequent on the "hybridization" of plants, and especially fruit-bearing ones. He indicated the vine and orange as suggestive of the direction in which experiments of this class might be conducted with most advantage to the colony. In the case of vines he would recommend the *Bowood Muscat* and the *Syrian*, and in that of oranges the *Navel* and *Paramatta*, as objects between which hybridisation might be advantageously effected. He then dwelt at some length on the practical aspect of the process as far as the vine and orange were concerned.

DESCRIPTION OF A NEW TILIACEOUS TREE FROM NORTH-EASTERN AUSTRALIA.

BY

BARON VON MUELLER, K.C.M.G., M. & Ph. D. F.R.S.

Among the Queensland timber samples procured by Dr. Bancroft, jun., with such praiseworthy zeal for the Indian and Colonial Exhibition, soon to be held in London, occurs also the wood of the following tiliaceous tree, concerning which I have been consulted by Mr. F. M. Bailey, the Government Botanist of Queensland. The branchlets transmitted by him for taxologic identification bear leaves, flower-buds, well-developed flowers, and fruit.

ELÆOCARPUS BANCROFTII, *F.v.M. & Bail.*

Tree over 100ft. in height; the diameter of stem over 2ft.; bark scaly of a brownish colour, about ½in. in thickness. Branchlets, thinly brownish, velvet-downy. Leaves, ovate-lanceolar, or almost ovate on rather long somewhat velvety stalks, entire at the margin, or slightly wavy, shining above, paler and without lustre beneath, and there the ascendent primary veins prominent, nearly glabrous on both pages; flower-stalks axillary or lateral comparatively short bearing only 2-5 flowers, at or near the summit—as well as the stalklets and calyces—thinly velvety-downy. Flowers, rather large, longer than their stalklets. Buds ovate-globular; sepals four, oblong-lanceolar, of thick consistence; petals four, glabrous, cleft at the upper end into generally three short roundish lobes without fringes; stamens numerous; filaments nearly or fully as long as the anthers, the latter glabrous, only slightly pointed; ovary greyish velvet-downy, four-celled, passing into an upwards glabrescent style. Fruit, very large, ovate-globular; endocarp, remarkably thick, somewhat uneven, and slightly foveolated outside, separable into four valves; cavity, one-celled. Seed one, very large, oblique-ovate.

On the Johnstone River; Dr. Bancroft, jun.

A tall tree; branchlets robust. Leaves, 3-5 inches long 1½-2 inches broad, rather smooth above, gradually narrowed at the base, the closely-reticulated veinlets subtle; no foveoles at the mid-rib beneath. Leaf-stalks attaining a length of from one to two inches. Flower-stalks comparatively thick, but generally not above an inch long, occasionally even shortened to ¼in. Stalklets, not bent downward, finally sometimes lengthening to one inch. Sepals ⅓-½in. long, pale silky inside. Petals somewhat longer, inflexed along the margin while in bud. Filaments slightly hairy. Anthers very narrow, about $\frac{1}{6}$in. long, unbearded. Style subulate, $\frac{1}{3}$-$\frac{1}{2}$in. long. Annular disk slightly lobed, rather broad, bearing the stamens chiefly on the summit, thinly velvety. Ovules generally four in each cell. Fruit measuring 1-1$\frac{1}{2}$in. exocarp thinly crustaceous. Mesocarp exsiccating, forming a stratum not very thick. Endocarp woody, the sutural lines very perceptible outside, the commissural spaces permanently cohering, but on forced separation showing a silky fibrous vestiture. Seed turgid, about $\frac{2}{3}$in. long; testa brown-black, smooth; albumen copious, almost amygdaline; embryo white, nearly as broad as the albumen and almost as long; cotyledons, foliaceously flat, about $\frac{1}{2}$in. long, oblique-ovate; radicle hemiellipsoid-cylindrical, several times shorter than the cotyledons.

These "kernels" have an agreeable flavour, and are eaten by the settlers. The wood of this tree is hard and durable, considerably resembling in this and other respects the American *lignum vitæ*—for which indeed it might form a good substitute.

This remarkable species bears alliance to E. Horckii, so far as the form of the leaves, the few-flowered peduncles, and the large size of the fruit are concerned; elongated filaments occur likewise in E. aristatus, E. amnœus, E. venustus, and some others, while the sutural indication is also well-marked in E. tuberculatus, E. ganitrus, and several other congeners—thus a transit is offered to Dubouzetia, which, indeed, may well be regarded as a subgenus of Elæocarpus, the valvular dehiscense of the endocarp being complete in Dubouzetia, according to the observations of Brogniart and Gris, while a close approach to its inflorescence is shown by Elæocarpus Bancroftii; the flowers of the latter however, resemble externally those of E. Guillainii (Vieillard) from New Caledonia, though the normally tetramerous calyx and corolla are quite exceptional in the genus Elæocarpus, nor are they occurring in Dubouzetia, and remind one of Sloanea, with which our new Elæocarpus agrees also in inflorescence.

Incidentally it may be here observed, that the discovery of a very particular Sloanea in New Guinea (S. paradisearum, F.v.M., *Papuan Plants*, I., 84) has strengthened the view, expressed by the writer of these lines already in 1864, that Echinocarpus should be subjugated to Sloanea. This opinion is also shared by Dr. von Szyszylowicz, who in a recent study of Tiliaceæ (Englers's Botanische Jahrleuecher VI., 454) likewise unites Echinocarpus with Sloanea, but, who, on the same occasion, felt inclined to refer Aristotelia Braithwaitii, *F.v.M.* (*Wing's Southern Science Record, Aug.*, 1881) to Elæocarpus, not having seen specimens which would have demonstrated to this excellent investigator the intenability of that opinion.

NOTICE OF A FISH APPARENTLY UNDESCRIBED,

BY

C. W. DE VIS, Esq., M.A.

Hitherto, the shores of Western and Southern Asia have alone yielded those few forms of the Scorpænida which have been distinguished under the general title Apistus. One species inhabits the Red Sea, and has been whimsically named *israelitarum;* the other entering the Pacific is a frequenter of the Indian coasts. Both have the pectoral fins developed as organs of flight; they agree also in having the anterior portion of the dorsal fin composed of fifteen spines. To these, the fish now brought under notice, through the instrumentality of Mr. R. A. Bulcock—a young observer of the fauna of Moreton Bay—is closely allied; and, notwithstanding that it differs in two structural features of some importance, namely, in having but fourteen spines in the dorsal fin, and the pectoral reduced to a size unfitting it for an organ of flight: I refer it to the same genus Apistus because it appears to me preferable to relax somewhat the character of a genus founded on two species only, rather than burden the system with a new one, which does not seem absolutely necessary. The following are the specific characters of this fish, which may from the place of its capture be called—

APISTUS CALOUNDRA,

D. 14/9, A. 3/7, Lat. 55, Tr. 7/17.

Pectorals moderately elongate, reaching to the third anal spine. Dorsals emarginate between the spinous and soft portions. A broadly white-edged black blotch between the ninth and twelfth spines of the dorsal—top of the webs between the first two spines also black. Upper surface of the snout, a broad band across the occiput, a narrow curved band from the snout through the edge to the base of the opercular spine, two large blotches on the upper part of the trunk connected and apparently traversed by three longitudinal bands, two horizontal bands on the soft dorsal, three vertical bands on the caudal, and the lower third of the pectoral more or less black.

The preorbital has in front two short spines directed forwards and the angle armed with a curved daggerlike spine broader than that at the angle of the preopercle. The mandible is furnished with two pairs of short tentacles. The height of the body is one-fifth of the total length; the length of the head three and two-thirds in the same. The orbit is $4\frac{1}{3}$ in the head, and the interorbit $1\frac{1}{3}$ in the orbit. The pectoral appendage is as long as the snout, the scales radiately ctenoid and very handsome.

NOTES ON QUEENSLAND ANTS,

BY

HENRY TRYON,

1.—HARVESTING ANTS.

The author of the "Proverbs," in his well-known admonition addressed to the sluggard, claims consideration for the economy of ants, and alludes to their habit of gathering their food in the harvest—on which account also he elsewhere refers to them as one of the four things which "are little upon the earth but exceeding wise." And again the Augustine poet—using the simile of ants in describing the busy preparations made on the eve of the departure from Carthage—refers to them as ravaging heaps of grain—warned by the approach of coming winter [Virgil Ænid, IV., 395-400]. And other so-called "ancients," amongst their fabulous relations concerning these insects, have mentioned similar habits.

This harvesting propensity of ants was for a long time discredited, and those who thought about the subject were content to accept the explanation of Gould [in "Account of English Ants," 1747], viz:—that these ancient writers had mistaken for seeds and grain, the pupæ—which the ants transport from place to place in order to locate them under circumstances best suited for their development; or, again, they would endeavour by learned exposition to derive some meaning from the expressions used—in allusion to this habit—other than afforded in their legitimate interpretation. Moreover, even the authors of that English classic, "An Introduction to Entomology" [Vol. II., pp. 45-46, Ed., 1817], were—commending the explanation of Gould—inclined to doubt the accuracy of the observations which had suggested allusions of the nature of the above, though they were of opinion that such a habit might possibly be found to exist amongst the ants of intertropical countries.

Since the time when these explanations served their purpose the ways of ants have been, and are, once more carefully considered, with the result of proving that "the parsimonious emmet provident of future" has really an existence in nature. Colonel Sykes* was perhaps the first to demonstrate the fact that these old authorities did not make use of poetic license in their similes and descriptions, by showing that harvesting ants really exist in India. This naturalist observed in June, 1829, ants bringing up to the surface seed from a store which they had accumulated in their subterranean nest, and which they must have gathered in the preceding months of January or February, when the *Panicum*—which was the grass from which the supply had been derived—ripens its seed. He concluded that on this, as on a similar occasion which took place in October of the same year, the seed had got wet during the prevalence of a monsoon, and was brought to the surface in order to dry it. Colonel Sykes, too, was very careful in verifying his facts, as he was aware that they militated against the observations of entomologists in Europe. His observations related to the ant, *Pheidole providens* (Sykes) West.

The Rev. W. Hope,† in 1837, drew attention to the providence of ants, and their habit of hoarding grain as winter store, in order to contrast what had been positively stated on the subject, both by ancients and moderns—including the narrative of Colonel Sykes, with the doubts expressed by the entomologists of his day. He at the same time referred to Bochart [*Hierozoicon*, Vol. III.] for citation of a host of authors all concurring in the same opinion, that certain ants presented this trait.

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* Trans. Ent. Soc., Vol. I., p. 101. London, 1836.

† Vid. "On Some Doubts Respecting the Economy of Ants." Trans. Ent. Soc., Vol. II., pp. 211-213. London, 1839.

Mr. T. C. Jerdon incidentally refers to the habit in the above-mentioned Indian ant, and especially dwells on its economic aspect.*

Mr. J. J. Lake describes the depredations of ants upon a pile of unthreshed wheat, lying on a threshing floor adjoining his house at Zante, and mentions that the seed so carried off was found to be stored up in the nests of these ants.†

In 1866 M Lespès wrote in the "Revue des Cours Scientifiques," on the same subject. In the same year also Dr. Gideon Lincecum related ‡ his observations concerning a Texan ant—"*Myrmica molefaciens*"—which was in the habit of sowing a particular grass, tending the crop, and afterwards reaping the harvest. These interesting particulars had already, in 1862, formed the subject of a communication to Mr. Darwin, § and they are again repeated, with some omissions, in an interesting popular article—"The Agricultural Ant of Texas"¶—by the same author.

The writer, however, whose published investigations have created the most interest, is Mr. J. Traherne Moggridge, who during a residence at Mentone in the south of Europe, in 1871-2, made the habits of the harvesting ants of that district his special study. Mr. Moggridge first noticed that the ants *Atta structor* *A. barbara*, and *Pheidole megacephala*, as autumn approaches, were in the habit of storing up the seeds of flowering plants, such as *Polygonum aviculare*, *Capsella bursa-pastoris*, and *Alsine*

* "Annals and Magazine of Natural History," series 2. 1854. Vol. XIII. Independent testimony to the accuracy of some of the observations recorded by Col. Sykes and Mr. Jerdon will be found in "Wanderings of a Naturalist in India," by A. L. Adams, M.D., pp. 38-39, Edin., 1867. On the economy of this Indian ant, the reader is also referred to the authors quoted by the Rev. W. Hope.

† Athenæum, No. 1950, March 11, 1865, p. 35.

‡ Proceedings of the Academy of Sciences, Philadelphia, 1866, p. 323.

§ Journ. Lin. Soc., London, 1862, p.p. 29-31; cf. S. B. Buckley, P. Ac. Philad., 1860, p. 445.

¶ Hardwicke's Science Gossip, Jan. 1868, pp. 1-5.

media, in excavations made by them in the sandstone rocks,* and subsequently was able to confirm his opinion that these ants also made use of stored-up seeds for food.† The considerable attention which this writer gave to the subject, is very evident on a perusal of his popular work on "Harvesting Ants and Trap Door Spiders," London, 1873. In this publication Mr. Moggridge reviews the Biblical and classical notices of the habit of storing-up grain by ants, and the explanation of these notices given by such entomologists as had considered them worthy of comment. He then mentions the occurrence of this habit in three distinct species of ants found at Mentone, and in six others—natives of other countries—whilst he at the same time dwells on the custom of ants carrying seeds only, but not necessarily, with a view to harvesting them.

He then describes and figures the heaps of rejected portions of seeds, found outside the ants' nests, as well as the granaries themselves. Mr. Moggridge observed that seeds whilst in the granaries did not germinate, though they did so when removed by him and afterwards sown ; and that when in some exceptional cases the radicle in stored grain did sprout, it was afterwards gnawn off—from which he concluded also that the ants first placed some seeds under circumstances favourable to their germination, and that this process was whilst in an early stage repressed by the ants themselves. These facts are interspersed with many relations concerning other peculiar habits of harvesting ants, and ample justice is done to previous writers, whose contribution to the history of the subject are copiously extracted and summarised.

The next writer who treats the subject systematically is Mr. H. Christopher McCook, author of "The Natural History of the

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* Proc. Ent. Soc., Lond., 1871. p. 47.

† Op. Cit., 1872. p. 8.

Agricultural Ant of Texas."* The work is the result of a three weeks' mission to Texas; undertaken by the author for the purpose of testing the accuracy of the statements made by Dr. Gideon Lincecum (pg. 142). Unfortunately Mr. McCook's visit was not so well timed as to permit of his being able to gain evidence of these ants actually sowing seed, but he had abundance of evidence that they reaped the harvest—were harvesting ants. This Texan ant differs from all other species possessing this habit, in so much as it clears a large and nearly circular space of ground around its nest, and it is on the outer border of this disc that the ant rice *(Aristida oligantha)* as it is called grows, entirely freed from weeds. The seeds of this grass are stored up by the ants in their nest amongst other seed; but, "that they are regularly sown in autumn," rests on Dr. Lincecum's authority only. Mr. McCook enters even more fully than Mr. Moggridge into the subject of "the ancient belief in harvesting ants; how it was discredited, and how restored." Then, again, Messrs. Treat and Morris, in the "American Entomologist" [op. cit. pp. 225-6; 228-9; 264-5] of the same year, viz., 1879, give an interesting account of two other harvesting ants (*Pheidole pennsylvanica* and *P. megacephala*) from New Jersey. Finally, harvesting ants have been alluded to by various popular writers on entomology, though Louis Figuier seems to have passed the subject over, in that form of his interesting work with which English readers are most familiar

The investigations of these and other authorities have made us acquainted with the existence of this remarkable trait in at least fifteen species of ants. These are natives of Europe,† Asia, and

* "The Natural History of the Agricultural Ant of Texas; a Monograph of the habits, architecture, and structure of Pogonomyrmex barbatus." [? *M.* (*Atta*) *molefaciens.*] London: Trubner & Co., 1879.

† We have Sir John Lubbock's authority for the statement that no harvesting ants live in England [British Association for the Advancement of Science, 1878, Section Zoology and Botany]. Mr. J. Curtis, however, states—and he paid much attention to ants and their habits—

America, and the habit is not necessarily restricted to ants of a tropical climate. They all belong to one sub-family of the *Formicidæ*, viz., the *Myrmicidæ*—ants endowed with a sting, and which have two joints in the peduncle connecting the thorax with the abdomen; but they are by no means limited to a single genus, or to genera closely allied. The genera including species of harvesting ants are *Atta*, *Myrmica*, *Pheidole*, *Pogonomyrmex*, *Œcodoma*, *Pseudomyrma*, and *Meranoplus*. All of these are morphologically speaking very distinct, and do not comprise species alone, in which this habit is predominant.

It will be readily understood then that, in so much as there is no characteristic structural feature by which this class of ants is distinguished, the peculiar habit of harvesting grain is not due to any special organization, but that it is rather the result of inherited experience—or what used to be called instinct—of the necessity of some such provision by reason of conditions acting from without; and a certain plasticity in the ant organization is all that need be taken into account in considerations relating to the adaptability of these ants, and this is often very noticeable, to fulfil the conditions which the possession of the peculiar trait has imposed upon them.

Scarcely any record of the occurrence of this habit amongst Australian ants is to be met with, though such a feature could not have escaped the observation of Mr. Damel, who, in the interests of the Godeffroy Museum, gave such assiduous attention to collecting the ants of Australia, and of Queensland in particular.

The first intimation of the existence of harvesting ants in Australia seems to have been made by Mr. W. E. Armit, F.L.S., in the following letter dated from Dunrobin, Georgetown, 19th July, 1878, and addressed to the Editor of " Nature ":—

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that *Formica braunea* is one of the species of ants which not unfrequently causes great loss to the farmers by purloining his seed when sown broadcast. [Morton's Cyclopœdia of Agriculture, 1855, p. 918.] That these seeds are also harvested may be regarded as at least very probable.

"I have lately discovered a colony of agricultural ants near Georgetown. The species is very small and red. My attention was first directed to these tiny harvesters by noticing heaps of chaff and hulls in a bare spot, situated in a grove of young acacia trees. The formicaries are entirely subterranean, being entered by a funnel-shaped tube. Roads diverge from this gate in four or five directions, and during working hours are alive with what appears like white insects, the little ants being covered by their load. Some of these ants seem to clean the grain, and carry out the husks, which form a heap round the opening to the nests. The clear space round each opening is small, certainly not more than eighteen inches in circumference, and a small mound round not more than six inches in height, is formed with the earth excavated in forming the nest. The only species of grain harvested is the seed of Perotis rara, which is light when quite ripe. I cannot give the generic name of these little fellows, never having devoted any special study to the family, but shall be happy to furnish specimens in spirits to any naturalist who will forward his address."*

Still more recently another of our members, Mr. Ling Roth, has written concerning an ant, which Mr. W. F. Kirby refers to as *Meranolopus dimidiatus* (Smith). "These harvesting ants are found at Mackay, Queensland. They climb up grasses, and carry away the seeds to their nests. The ground near their nests is generally strewn all over with the husks they have brought to the surface."†

During last autumn the writer observed on Spring Hill, Brisbane, small ants continually passing to and fro from their

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**Nature*, Oct. 17, 1878, Vol. XIX., p. 643. Since the date of this letter Mr. Armit has left the scene of the operations referred to, and so specimens of the harvesting ants, which there is reason to think will prove different to those subsequently mentioned, have not yet been at the disposal of the writer for examination.

† Journal of the Linnean Society, Vol. XVIII. p. 328. Lond., 1885.

nest; some homeward bound heavily laden with the florets of the grass *Eleusine indica*, containing ripe seed, and others setting out for some plants growing a few yards distant, where a further supply could be obtained. The nest to which these seeds were carried, and where they afterwards harvested, was entirely subterranean, and accessible only by means of a small hole, the neighbourhood of which, to the extent of two or three inches, was covered with the "chaff" of grass seed, and was constantly receiving additions of the same nature from the small ants, who were busily occupied in carrying these dejecta to the border of the heap, and there without fail depositing them. On opening the nest it was also observed to be plentifully stored with winnowed seed of this same grass *Eleusine*.

These insects belong to the family Myrmicidæ and to the genus Pheidole—ants remarkable as having four different classes of members in their communities, viz: the males, the females, the smaller workers (neuters), and the larger workers or soldiers (neuters). The latter class is composed of individuals much larger than the workers proper, they have heads also bigger than their bodies, and are provided with powerful jaws. These soldiers are comparatively few in number, and seldom roam many inches from the nest, where they are probably occupied in separating the glumes from the grain, in the grass florets, and other similar labours.

As far as the writer has observed, these ants do not restrict their attention to grass seeds of one or more kinds, neither to this description of seed only. Exceptionally they carry off other vegetable matter, and sometimes animal matter, perhaps a minute curclulio which has been long dead, a portion of another ant, and at another time insect eggs. The latter habit is a little peculiar; the writer could not refer the eggs observed in this situation to any particular insect, and from their shape does not suspect that they were those of aphides; though ants are known to transport the eggs of these plant lice to their nests, and there as foster-parents to tend them until they are hatched, when they can avail themselves of the food supplies to be derived from the resulting animated sugar-pots, whilst these are still under their care. Moreover, those ants which milk aphides are not exclusively confined to this class of food, as may be easily observed. The ants at present under consideration do *par excellence* feed on grass seeds, which they also store up, and in case of partaking of other food, at such times as grass seed cannot be obtained, reject a considerable portion of it around the approaches to their formicary.

This harvesting ant is not uncommon in the neighbourhood of Brisbane, and is very plentiful in the Botanical Gardens, where its nests are usually surrounded by an accumulation of the glumes of *Eragrostis brownii.* It is to be hoped that it is not responsible for any want of success which may have succeeded sowings of small flower seeds by the gardeners of that establishment; but, though the present writer does not wish to impute any such action to these little emmets, in explanation of a probable occurrence which may be accounted for by other considerations, usually found in the mind of the experienced gardener, he cannot help calling to mind what Mr. Jerdon has written concerning *Pheidole providens* (Sykes) West. —the ants which were the subject of his observations. It is as follows:—"They carry off large quantities of seeds of various kinds, especially the small grass seeds, and as every gardener knows to his cost, more especially garden seeds. They will take off cabbage, celery, raddish, carrot and tomato seeds, but are particularly partial to light lettuce seeds, and in some gardens, unless the pots in which they are sown be suspended or otherwise protected, the whole of the seeds sown will be removed in one night. I have also had many packets of seeds (especially lettuce) in my room completely emptied before I was aware that the ants had discovered them."*

* T. C. Jerdon, An. and Mag. of N. H., Series 2, 1854, Vol. XIII., p. 50.

As illustrating the wide bearings of the subject of harvesting ants it may be of interest to remark that Mr. Moggridge approached it not as an entomologist, but as a botanical student. Having casually noticed the habit, he was prompted to make the observations detailed in his work, by the consideration that such habits in ants might be related to the sudden occurrence of plants in certain localities where they had not before been met with, and especially on soil which had been thrown up in digging; the late Mr. Bentham having already, in 1869, directed attention to the little information existing on the origin of plants in such situations.* Nor was Mr. Moggridge led to his investigations, in the first instance, by the purpose of corroborating the testimony of ancient writers; for he only afterwards learnt that European authorities, on the habits of ants, had discredited their statements.

That this Brisbane harvesting ant also, is an important agent in the local dispersion of plants—especially weeds—and is connected with their sudden appearance on heaps of soil excavated from a depth, is sufficiently demonstrated in the following observations. The ants of one nest were noticed to be harvesting the seeds of *Portulaca oleracea*, Linn., and of *Amaranthus viridis*, Linn. —both common weeds, and growing at a comparative distance from the nest. These seeds had remained stored upin their nest for some time, when rain suddenly came on, and under its influence the seeds—especially those of the latter plant—commenced to germinate. Of those which had already thrown out a radicle, this was bitten off and brought to the surface; some of these

* On the occasion on which Mr. Bentham directed attention to this state of things he referred to as a *supposition* only, the statement of Alphonse de Candolle that: "Il faut donc regarder la couche de terre végétate d' un pays comme un magazin de graines au profit des espèces indigènes,"† since no direct evidence of the existence of subterranean stores of seeds had been met with, neither by himself nor by any one whose recorded observation he had seen. Proc. Lin. Soc., Lond. Presidential Address, May, 24th, 1869. †[*Geographie Botanique Raisonée, p*. 625. *Paris,* 1855].

seeds were also gnawn into, and the ruptured black perisperm —containing more or less food substance—in like manner rejected. Other seeds, which had swollen only in response to the moisture, were carried up for the purpose of being dried and re-stored. In the midst of these operations, however, rain came on again, and the ants retired, leaving seeds on the surface. These immediately germinated, and a small patch of *Amaranthus* grew up, marking the site of what was before a nest of harvesting ants, quite isolated amongst plants of different character. On a second occasion a nest, in which much seed of *Eleusine indica* was known to have been harvested some months since, was dug up. Some of the grass seed selected from the nest was afterwards sown; also some of the earth from the nest which was known to contain both seeds of this plant, and of another species of Amaranthus. In both cases the sowings were made in situations remote from places in which any of these plants were already growing, and as a result, in the course of time numerous plants of both *Eleusine indica*, and of this second Amaranthus, sprang up in these new localities, where they continue to flourish.

The genus *Pheidole* to which—as above remarked—the small ant belongs, has representatives throughout the world, and is rather a large one; and, though the writer has met with descriptions of, or references to, forty-eight different species, this number will probably be found to fall very short of that of the species which really exist, especially as many members of this genus are, comparatively speaking, diminutive insects or have a very restricted range. Only six of the forty-eight species are referred to as harvesting ones, viz., two in New Jersey, two in south Europe, one in India, and the present example from Queensland. The habits of the remaining species are very variable, several being found burrowing in rotten wood, and one —*P. javanica*, Mayr—is reported as being restricted to the curious plant *Myrmecodia* (which derives its name from this ant relationship) in which it excavates its galleries.* Two species at least in Queensland are almost entirely nocturnal in their habits, are found in decaying and decayed wood, and probably contribute towards the destruction of forest trees.

The following is a description of the workers of this harvesting ant:—

PHEIDOLE *sp.?*

Workers (major).—Length, 5 m.m. (nearly $3\frac{1}{2}$ lines); head and thorax, reddish chestnut brown, front border of head and mandibles almost black, 2nd node of petiole and abdomen very dark brown, legs, yellow-brown; hairy; dull, except abdomen, which is bright; mandibles, striated, with punctures here and there on the entire outer surface, masticatory margin with three very obtuse blunt low teeth; shaft of antennæ not reaching beyond the middle of the length of the head. Head longer than broad, with parallel sides; posterior angles rounded and swollen with a deep longitudinal groove dividing the posterior portion; the whole surface of head densely and finely punctate; covered with wrinkles, which are anteriorly longitudinal, converge as the groove is approached, and are transverse and reticulated on the posterior surface. Clypeus almost smooth, with a rounded emargination on its anterior border. Frontal laminæ short and widely divergent. Thorax densely finely punctate. Pronotum and mesonotum not distinct, forming an elevated disc, with rounded-angular sides and truncated posteriorly, transversely wrinkled, not transversely impressed; metanotum with two sharp teeth, with transverse wrinkles anterior, and densely punctate only between and posterior to them. Petiole densely finely punctate, anterior node compressed, transverse, emarginate above, posterior node not compressed, transverse, with a blunt cone on either side. Abdomen smooth, silky, microscopically netted.

Workers (minor).—Length nearly 3 m.m. Reddish-brown, joints of legs and tarsi yellow-brown; dull, except abdomen, which is silky-bright; with erect hairs here and there,

* Mr. H. O. Forbes had painful experience of this fact on his first acquaintance with *Myrmecodia,* the life history of which he has so well illustrated. [" A Naturalist's Wanderings in the Eastern Archipelago," pp. 79-82.]

most conspicuous on the abdomen, and depressed hairs on antennæ and legs. Mandibles, with a few hairs on the outer surface, longitudinally wrinkled at the base. Head closely and finely reticulate-punctate, with longitudinal wrinkles. Clypeus longitudinally wrinkled. Scape scarcely reaching, and not exceeding, posterior margin of head. Thorax closely and finely punctate, without mesothoracic impression, pro- and meso-notnm with reticulate wrinkles; a short excrescense sometimes present on the sides of the disc; metanotum with two conspicuous spines. Petiole closely punctate, 1st node emarginate above, 2nd node swollen with pyramidal sides. Abdomen smooth.

Judging only from the description given by Dr. Mayr [" Die Australischen Formiciden," Journ. des Mus. Godf. Heft XII., p. 106, Hamburg, 1876,] this species of Pheidole seems to most nearly approach his P. longiceps. Compared with other examples of the genus found in the vicinity of Brisbane, its colour will at once distinguish it amongst them, as well, perhaps, as the great disparity in the sizes of the two classes of workers, and the excessive development of the head amongst the workers major.

MERANOPLUS.

Recently in an examination of some invertibrates brought by Mr. F. Blackman, from the neighbourhood west of Rockhampton, some ants were noticed belonging to a genus known to include harvesting species, which explained, as was then surmised, and as was afterwards proved, the occurrence also in the collection of a box containing a quantity of the empty glumes of a grass belonging to the genus *Andropogon.*

These ants were much larger than the ones which are above mentioned as occurring at Brisbane, and were only represented in the examples procured by workers, of one description, and male insects. Concerning these ants and their habits, and in reply to a series of interrogations, Mr. Blackman informs me, to the following effect:—

The ants in question were found at Barwon Park, near Blackwater, and nearly one hundred miles to the west of Rockhampton. The soil in which they had elected to place their nest was of that description known as "chocolate soil," a designation which should convey a pretty precise idea of its colour at any rate. This nest was subterranean, and approached by a nearly circular entrance, 3 m.m. in diameter. Its immediate neighbourhood was not conspicuously bare of herbage, but what more especially distinguished the nest was a heap of the hairy husks of some grass, piled loosely around it. Observing this heap, numerous ants were soon noticed coming towards the nest, each heavily laden with a floret of a grass. These florets were found to contain ripe seed, and to be derived from a grass, growing plentifully in the locality, which they seemed to harvest in preference to the seeds of other varieties of grass. The ants carried the florets by fixing their well-developed jaws in the basal portion, and though such loads would seem to impede very much their progression, and though the loose heap of empty husks, surrounding the entrance to their nest, would appear to impose a formidable obstacle to their gaining it, it was not a little surprising to witness the adroitness with which they accomplished their object in view, and how skilfully they would manœuvre, and eventually extricate their load from every obstruction with which they came in contact. Whilst these operations were going on ants were ever and anon emerging from their granary, bearing with them husks of the same grass which were empty and deprived of their seeds. These seeds were afterwards found in plenty in the galleries of the nest.

No disparity between the sizes of the ants occupied in the two different operations mentioned was noticed, nor was there anything seen to militate against the conclusion that the same ant which carried a grass-floret into the nest may have also removed the seed whilst below and returned with the empty husk to the surface.

These ants appeared to work slowly and deliberately with a persistent determination to do their duty, and if molested scarcely quickened their movements if at all, seldom forsook their charge, and often adopted a squatting attitude* the very opposite of defiance.

On examination of the material brought by Mr. Blackman from his Barwon Park estate, the writer found (1) a number of reddish brown very hairy ants, which, from the lateral position of the frontal laminæ, belonged to the Cryptoceridæ—a group of the Myrmicidæ. Their antennæ were 9-jointed, including the scape, and this feature, associated with the presence of other characters, would place them in the genus Meranoplus† (Smith), as restricted by Mayr.‡ (2.) A quantity of a chocolate-coloured earthy material containing a number of grass seeds mostly of one kind, though there were amongst them a few smaller rather roundly ovate seeds. These seeds were carefully examined for evidence of their having been gnawed or otherwise tampered, without any being found; and there was little doubt but that they would grow on being planted. The soil also contained a number of small shrunken bodies, which, on soaking, were found to be the dried up hairy larvæ of some insect. (3.) There was also a quantity of the husks of a grass of a single species Andropogon intermedia, with a few glumes derived from another grass, a species of Pappophorum, also amongst it.

The genus Meranoplus, to which as above stated these last harvesting-ants belong, is not nearly so rich in species as is

* This is a very common trait in ants. The Pheiole above referred to as exhibiting harvesting propensities in the neighbourhood of Brisbane is frequently robbed in returning food-laden to its nest by a species of Lasius, when it adopts this attitude. The manner also in which various Queensland ants allow themselves to be borne away unresistingly by their captors is, too, a phase of the same habit.

† F. Smith, "Monograph of the genus Cryptocerus," Trans. Ent. Soc. 2nd Series, Vol II. pg. 213, London, 1853.

‡ Dr. Gustav L. Mayr, "Formicidæ," p. 26 (Reise der Novara, Zoologischer Theil. Bd. II. Abth. I., Wien., 1865.)

Pheidole, and only twenty-one* appear to have been described. Of this number six are stated to be Australian, five to inhabit the East Indian Archipelago, two India and Ceylon, one South Africa, six South America, whilst the habitat of the remaining one is uncertain.

I do not find any mention of ants belonging to this genus being harvesting species, except such as is contained in the short note of Mr. L. Roth, previously cited, relating to the habits of a particular insect which Mr. W. F. Kirby has identified with *M. dimidiatus*, Smith.†

The present species, as far as the workers are concerned, is one of the largest of the genus, and appears to differ from those hitherto described, amongst which the following definition of its chief characters may serve to distinguish it:—

MERANOPLUS, *sp.*

Workers.—Length, 5.5 m.m. Almost uniformly ferruginous, brown, abdomen red-testaceous or sometimes even almost black. Beset with long, thin, outstanding hairs. The whole upper surface, except the abdomen and the posterior portions of clypeus and metanotum and side of thorax, covered with coarse, often reticulated, longitudinal wrinkles. The pro- and mesonotum together form a convex disc, about as broad as long, bounded laterally by overhanging ridges, which are produced anteriorly into blunt teeth, and have tuberosities in the middle of their length. The metanotum

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* This number includes all the species referred to by Mr. F. Smith, who paid special attention to the Cryptoceridæ, under Meranoplus. [Vid. Trans. Ent. Soc., Lond., 2nd Series, Vol. II. pg. 213; ib. 3rd Series, Vol. I. p. 407; ib. Vol. V. p. 523; ib., 1876, p. 603; and Catalogue of Hym. Ins. in Col. B.M. Pt. VI. Formicidæ p. 193, 1858.] Dr. Mayr has, however, adverted to Mr. Smith's inaccuracies [l.c. Introduction p. 4 and Journal des Museum Godeffroy Heft XII. p. 112, Hamburg, 1876], and indicated that some of these twenty-one species should be more correctly included in the typical genus of the family, and not in Meranoplus, as not possessing the generic characters *really* present in the typical species, viz., M. petiolatus, Smith and M. bicolor, Guér.

† "Description of New Species of Cryptoceridæ." Trans. Ent. Soc., Lond. 3rd Series, Vol. V., p. 523.

descends and is armed with two posteriorly and outwardly directed sharp spines, from the bases of which ridges extend to the hinder lateral angles, where they form tuberosities. Hinder border with a semi-circular deep emargination, surface between and behind the spines smooth. Nodes of petiole sub-equal, each longitudinally wrinkled, anterior one angular and posterior one rounded above in longitudinal section. Abdomen microscopically punctate, with larger hair-bearing punctations. Head rounded posteriorly at the angles, the margins produced anteriorly into blunt projecting processes. Clypeus sunk into a deep fossulet, having a small anterior mesial elevation, and two prominent teeth on its margin. Mandibles punctate and wrinkled, having four teeth, of which the outermost is largest. Maxillary palp five-jointed, 1, 2, and 3 joints subequal, 4 and 5 together scarcely exceeding third. Labial palp 3-jointed, joints subequal. Antennæ densely clothed with depressed hairs, scape less than flagellum, with a distal expansion on the side apposed to it. Attennary fossa reaching little beyond eyes. Legs clothed with long ascending hairs.

In size this ant approaches *M. diversus* (Smith), from Champion Bay, with which it agrees in other characters also. The entirely rugose petiole and its larger dimensions, amongst other features, distinguish it from *M. hirsutus* Mayr, from Gayndah.

EXHIBITS.

1. The scale of *Apistus* as a microscopic object.

2. Two different kinds of harvesting ants, together with samples of the grain and rejected empty grass glumes from their nests.

3. A barograph tracing for September, accompanied by a comment on the chief meteorological phenomena corresponding to and in explanation of the variations in the curve, by Mr. J. Thorpe.

FRIDAY, NOVEMBER 6, 1885.

In the presence of His Excellency Sir Anthony Musgrave, K.C.M.G. The Hon. W. Pettigrew, M.L.C., in the Chair.

NEW MEMBERS.

Lieutenant H. C. Pritchard; Mr. A. Banks; and Mr. Rainsford Hannay.

DONATIONS.

"Journal of the Straits Branch of the Royal Asiatic Society," December, 1884, No. 14. Singapore, 1885. "Notes and Queries," No. 1. Singapore, 1885. From the Royal Asiatic Society, Singapore, 1885.

"The Victorian Naturalist," Vol. II., No. 6. Melbourne, October, 1885. From the Field Naturalists' Club of Victoria.

"Dun Echt Observatory Publications," Vol. III. *Mauritius Expedition*, 1874. *Division II.* Aberdeen, 1885. From the Earl of Crawford and Balcarres.

"Verhandlungen des Vereins für Naturwissenschaftliche Unterhaltung," 1878-1882, Band V. Hamburg, 1883. From the Society.

The following papers were read:—

CONCERNING SOME SUPERSTITIONS OF NORTH QUEENSLAND ABORIGINES.

BY

E. PALMER, Esq., M.L.A.

Amongst students of the subject it is now generally conceded, even by the few who do not recognise the universality of this belief, that it is very doubtful whether any so-called savage tribes are altogether destitute of the conception of a future state. Some people, however, in spite of the conclusions of specialists, deny that the Australian blacks have any such belief, and in support of their conclusions point to the silence in this matter of the early explorers, in the published records of their investigations; or produce evidence, from the many narratives in which such a belief is alleged, of ideas having being attributed to the blacks undoubtedly derived from the system in which the narrators have been themselves disciplined. I fully recognised the force of the latter objection, and accordingly in gathering the information now related was careful to eliminate the possibility of such an event. With regard, however, to the silence of the explorers, I would insist that their opportunities, in passing from one tribe to another, being never long familiar with any one spoken language, were not such as to enable them to arrive at any conclusion on the subject,* and especially so when it is borne in mind that ideas relating to its superstitions are such as the savage mind finds it difficult to give expression to, even when the natural reserve, especially with strangers, in these matters has been overcome.

The remarks in this paper have for the most part reference to the beliefs of the blacks of the *Mycoolon* † tribe, a tribe which occupies a territory eighty or ninety miles in length, and nearly the same in width, situated about one hundred and twenty miles to the south of Normanton—a post and telegraph town in the Gulf of Carpentaria—and embraces both the Flinders and Saxby Rivers within its hunting grounds.

These items of information were taken down in writing from natives at first hand, and their genuineness was verified in many instances by the separate examination of different black "boys."

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* *cf.*, G. Bennett's "Wanderings," London, 1834, vol. I, p. 13.

†The prefix *My-*, which is also common to the designation of other tribes adjoining that of the *Mycoolon*, is said to signify short words or short language.

No information was accepted where any traces of white man's ideas were detected. In fact the "boys," though employed on the station as stock-riders, were almost uncontaminated by civilised ideas, and they knew nothing of what blacks call "devil, devil" or "jump up whitefellow," nor did they entertain any foreign religious ideas whatever except their own native traditions.

These "boys" acted as the medium of communication between the writer and an old man belonging to their tribe named *Plungren.* Amongst these Mycoolon blacks, as in every tribe in Australia perhaps, there are certain old men who are the repositories of the numerous traditions and superstitions, and who alone can perform with efficacy the various ceremonies attendant on the healing of the sick. These doctors also instruct the young men in the beliefs of the tribe and generally initiate them as to the proper conduct of their lives, and this they do at special meetings—known elsewhere as Bora meetings—held for the purpose. It is their special privilege to hold communication with the spirits of the departed from amongst them, by which means they become possessed with much and varied knowledge, and this they impart on occasion to the tribe. *Plungren* was one of these doctor-men, was of about sixty years of age, and was the father of several sons all young and in the service of the station as riders. He was a tall man, of a very active temperament, and of lively intelligence, well versed in all matters relating to tribal traditions. He was quite unable to converse in English.*

* As an illustration of the character of this remarkable man I may add, that he was much respected by all the people of his tribe on account of his ancient prowess and deeds of pluck. He was particularly renowned for his endurance in the chase and for fleetness of foot, and obtained the name of *Plungren* in consequence. It is said of him that being at one time in the country of other blacks—the *Mygoodathy*—he was chased by the whole tribe for upwards of fifty miles, and that although he had many narrow escapes he ultimately outstripped his pursuers and returned in safety to his own people. Finding, too, that his little toes were a nuisance

Their Origin.

They seem to have no theory relating to their whence nor concerning their arrival in the country. They are impressed with the belief that there were blacks in the land before them, and speak of them with vagueness and wonderment. Not only their present and future but their past also is in some way related to the stars in the heavens—which connection is the subject of their legends.

Production of Rain, &c.

They have firm faith in the power of producing rain being possessed by many of their number. The means adopted, by those who have this faculty, are as curious as various. Some of the Gulf tribes skin a native cat (*Dasyurus*), and hang it in a tree; or break up mussel shells, with the fish in them, and return the material to the water; others gather up dust, throw it into the air, and then blow upon it with their breath; whilst others, again, steep the entrails of opossums in water, accompanying the operation by the performance of certain ceremonies.

Knocking out the Front Teeth.

The blacks knock out their two front teeth, for they believe that when after death they enter into the future state—*Yalairy*—they will be thereby qualified to drink of the good clean water; and, unless they have undergone this operation whilst on earth, they will only partake there of thick and muddy water.

Crystal.

Particular crystals, called *Roré*, play an important part in many of their ceremonies, and are regarded with feelings of superstitious reverence, as in some way connected with their future existence. These crystals are retained by the principal of the old or medicine men of the tribes, who produce them when occasion requires, but at other times carefully conceal them. The

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and impediment to him, catching in the grass, as he expressed himself, he deliberately removed them, and accordingly has now but four toes on either foot.

source, too, of these crystals they profess to be a mysterious one. They are either obtained from the inside of blacks, being sucked or drawn out from them by the medicine men, or are found with some ceremony in the mountain districts, as the result of special expeditions, occupying some months, during which much privation and hardship is endured. These crystals play an important part in connection with the ceremonies attending the coming of age of their young men, when the latter are initiated into the mysteries of the tribe, but they are also used for other purposes, such as for buying a "gin" from her uncle or father.

Witchcraft.

The black lives in continual dread of mysterious death, which he attributes not so much to some spirit agency as to the machinations of his foe or foes. In fact he scarcely regards death, unless due to accident, or even sickness, otherwise than as the work of some enemy who may be separated some distance from him, and he believes, too, that in his turn he can in like manner work destruction. This belief is almost universal amongst the Australian blacks. The Mycoolon tribe entertain many peculiar ideas as to the way in which these evil influences may be exercised. The blacks of this tribe can, as they think, command the thunder and lightning, the wind and the storm, to aid the accomplishment of their evil purposes, but have also special methods.

Beecharrah.

By this designation a death is implied, which is attributed to the following series of events: The victim is killed by an invisible spear. Some enemy of his (having prepared a spear by cutting it nearly through, by a circular incision with a mussel, a few inches from the end) steals stealthily upon him, as he is engaged in the chase, creeping from tree to tree, and while still unperceived, hurls it at him. The spear strikes him, but he is unconscious of the fact; it penetrates his body, but without rent or blood; the end of the spear being broken off sticks firm in his flesh, but he feels it not. He continues his hunting quite ignorant of what has happened, and returns to his camp as evening comes on, knowing nothing of the evil which is impending. As night approaches he is sick, symptoms become more urgent, he is light-headed, plays, laughs, and makes a great noise, then he grows delirious, and soon succumbs entirely under the influence of the Beecharrah.

Thimmool.

This name denotes another very common superstition amongst the blacks. In this case the mysterious weapon is a pointed fragment, six or seven inches long, said to be derived from a human leg bone, and it is believed that both sickness and death are caused by this bone when held over anyone whilst asleep, the weapon being at the same time pointed at but not allowed to touch his body. Death supervenes as the effect of this occult cause, as in the above instance. The blacks live in great dread of the *Thimmool* being pointed at them.

Marro.

The name of another method of working evil which is especially adapted for dealing with a black when at a distance. The instrument, *Marro*, employed in this case is derived from the pinion of a bird, and consists of two small pieces of bone fastened together by wax, in which is placed some hair of the person whose injury is intended. The method of procedure with this charm, is to place it on or stick it in the ground, surround it by fire, and afterwards set it in the sun, and again return it to the fire. Varying the ceremony according as the intention is to kill or only cause sickness to their enemy, and when they think their victim is sufficiently sick, or they are otherwise satisfied, they suspend the effect of the charm by placing the *Marro* in water.

Wingo.

With regard to this superstition it is stated that the object to be accomplished is that of secretly removing the kidney fat from a black fellow, for subsequent employment in catching fish, great luck befalling the fisherman by reason of its use. The invariable consequence of this however is the death of the victim of the operation. A black is described as preparing a rope from fibre or bark and then, having watched for an opportunity whilst his enemy is asleep, partially choking his victim by winding this rope about his neck. The sleeper is not aroused and his enemy proceeds to open his side under the "short rib" and, having removed the kidney fat, fastens up the inside by a cord, quickly replaces the skin, whereupon the opening immediately heals over. No blood is lost during the operation, of which too no signs subsequently remain. The man awakes and, unconscious of what he has undergone, pursues his daily life as if nothing amiss had befallen him. In progress of time however he has some misgivings and imagines he has been the victim of *Wingo.* He is hunting and has ascended some tree in quest of an opossum, and in jumping down to catch it as it would escape, he makes an unusual effort, he feels something give way, the cord by which his enemy has fastened him internally has snapped asunder, he is aware of the hopelessness of his condition, returns to the camp, and fully alive now to every thing which has been done, resigns himself to his fate and passes away.*

A feature in the habits of these aborigines, which is certainly worthy of note, is the care which the sick, aged, or infirm receive at their hands. These they occasionally carry from camp to camp, reserve the best of food for their share, and suffer no one to make a jest at their expense, in allusion to their sufferings. And when, in spite of this attention, death ensues, they

* This superstition, with certain modifications, is very prevalent amongst the different tribes of the continent. In some tribes the victim is stunned by a blow of a stick and his kidney fat abstracted, a bunch of grass inserted, and he is left to linger till death.

never fail to mourn for the victims; the mourners smearing their faces with white clay, and cutting their heads. In addition to this too, abstinence, with respect to certain food, is practised for some time afterwards, and even when months have passed by, the death song * is nightly chanted.

Spirits.

The blacks believe that their existence on earth does not terminate with the death of their bodies, and that the spirits both of the men and women still survive. In this spiritual state they are known as *Limbeen-jar-golong*, the word *Limbeen* denoting the bark of a tree, a name with, perhaps, some metaphorical allusion to the fact that during the day the spirits remain where the bodies which once contained them were deposited, and only show themselves at night—coming as it were from behind the bark of a tree. The old man Plungren was very familiar with these spirits, and had arrived at a somewhat remarkable estimate of their personal appearance. They were all bone as it were—mere skeletons—and yet they possessed long ears, erect like

* With reference to this particular class of musical expression, the following interesting observations were communicated by Mr. P. R. Gordon to the Brisbane *Courier*, whilst this paper was being revised for publication:—" In the ordinary corroboree the song or chant is carried on throughout in a major key, whereas the death wail, or song, is always chanted in a minor key. So that the minor key would appear to suggest itself to savages, as well as to highly cultured musicians, as the most appropriate for giving expression to feelings of sorrow. So far as I can remember, Handel's " Dead March in Saul "—which is in the natural key of C major—is the only notable exception of doleful music being written in a major key. About thirty years ago a Murray chief died, and, in the middle of the night, a large camp of blacks, near the hut in which I was sleeping, set up a death wail, the theme or refrain of which was so frequently repeated, that I was enabled to roughly write down the music. All of a sudden the whole camp, as if by a preconcerted signal, burst into what might be described as a *coda* in a major key. On inquiry next morning, one of the younger blacks (for I found the elder ones severely silent on the matter) informed me that the first part was a lament for the chief, and the short coda was a menace to the spirits of the hostile tribes present, that the death of their chief would be revenged." [*Ed.*]

those of a horse, eyes burning bright as stars, and their nails were long and sharp as the claws of an eagle hawk. In other respects they resembled the blacks themselves; there were both men and women amongst their number; they spoke as they did, and subsisted in the same manner. The men amongst these spirits invariably appeared with a crooked stick in their hands—not a boomerang, but a straight stick with one end crooked or bent. This stick the blacks designate *Wommolongo*. The women carried yam sticks only. These spirits do not hold communication with the ordinary members of the tribe, only with the old doctor men, such as Plungren. They are said to leave their graves at night, and return to them again when dawn approaches; and some of the blacks moreover believe that they frequent old camping places and fires. The blacks do not regard the spirits of former members of their own tribe with any fear, but look upon them as generally beneficient, though the *Limbeen* of hostile tribes are sometimes thought to use the *Wommolongo* for their destruction, and certain localities supposed to be frequented by these evil spirits are avoided. In fact they are good fellows, and amongst other services, perform in the presence of the old men corroborees and dances, and sing songs, which these old men subsequently repeat to the tribe. The spirits themselves, when about to communicate with these old men, like strangers do not at once boldly approach them, but are restrained as if by some sense of fear. First one will advance; whilst his associates hold aloof, squatting down some distance off, or resting in the branches of trees. At length, confidence having been established and this reluctance to approach overcome, the other *limbeen jargolongs* may be heard jumping down from the trees or seen advancing. After this intercourse with the old men has finished, the latter return to the camp, there to repeat to their followers the many lessons which they themselves have learnt from these spirits.*

* As an instance of the prevalence of this belief in spirits amongst

YALAIRY.

The spirits of the dead do not for ever roam about, and hold this communication with the old men. After a while, they leave the earth, and proceed to *Yalairy*—another home.

This *Yalairy* is supposed to be amongst the stars. They know not its exact situation. The conception which the blacks form of it seems to be a mere embodiment of their views as to what constitutes happiness on earth. It is a great hunting ground, well stocked with all the game they are familiar with on earth—kangaroos, wallabies, emus, &c. They have their dogs there, and can enjoy the shade of the forest, or the clear water of the running stream. Both men and women go there. Whilst there, they hunt, eat, and sleep; but, as this new country is superior to that which they have left, so is their life happier—no anxiety on account of hunger, no sense of insecurity from enemies is ever experienced. Amongst the different animals which occupy *Yalairy*, conjointly with themselves, or are met with on their road thither, they particularly mention two large carpet snakes, which they speak of as *Koomera*. These are of prodigious size—forty miles long, according to one black-fellow's testimony. These snakes are the source of the only dread they associate with existence there. When killed and eaten, they are said to be renewed or to be replaced by two more.* The blacks have rather different ideas as to the route pursued by these spirits in gaining this *Yalairy*. The old man—Plungreen—when interrogated on the subject, pointed with his head towards the north, and other blacks, residing farther south, are said, on dying, to have gone up, as by a kind of ladder, by way of the Southern Cross.

Queensland aborigines, and as illustrating a different view held as to the nature of the spirits themselves and the functions they subserve, I may mention its occurrence amongst the blacks of the Mitchell River. In this case the spirits inspire great dread, and their influence is especially feared at night, when they are said to utter a shrill piercing cry, like that of a white owl.

* Similar to the myth of the ancient Greeks regarding the Python.

Another tribe—the *Yerunthully*—speaking a different language from that of the *Mycoolon*, and whose hunting grounds—at the head of the river Flinders—are nearly three hundred miles distant from those of the latter, believe that the ascent is made by means of a rope, and that what we call a shooting star, is merely the falling of this rope, on being let go after the ascent has been accomplished.* When the heavens have been reached, the journey to *Yalairy* is continued along the road indicated to them in the path of the Milky Way, until their destination is reached. They believe, too, that the stars are the spirits of those blacks—men, women, and children—who lived long prior to the present generation, as well as of the animals which shared with them existence then.

Astronomy.

As a consequence of this phase of the belief in the future existence of their spirits, the whole phenomena of the heavens, as well as any changes in them, are regarded with much more significance than they otherwise would be, and the blacks have learnt to associate the recurrence of these changes with the ripening of particular fruits, or the visitations of certain animals, on which their subsistence depends.†

To recount what the *Mycoolon* blacks relate concerning many stars and groups of stars, would presuppose much greater

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* Whether the blacks connect this rope in any way with the appearance of the tenacious gum which exudes from some of the acacias, and which they eat, I am unprepared to say; but the *Mycoolon* blacks, amongst whom this gum is known as *Thunga,* believe that falling stars strike the trees from which it is derived, and that the gum subsequently exudes at the spots where these trees have been stricken.

† According to the position of the constellation "Orion" in the heavens the blacks of the Wide Bay District knew of the flowering of the *Banksia marginata* or honey-suckle, and accordingly gathered, from a long way inland, to the coast district, where this tree is found in abundance, to suck the copious supply of honey which its flowers afford. So, too, guided by the appearance or rising of certain stars, the aborigines flock from long distances to the Bunya Mountains there to fatten on the fruit of the *Bunya,* Auracaria Bidwillii, during many weeks.

acquaintance with astronomy than most colonists possess. The following facts are, however, of some interest:—The sun they regard as a female; the moon—*Ngegarru*—they say is a male; and the members of one tribe, on the Saxby river, believe that it is a black-fellow, who at one time killed a lot of their people, and whom they afterwards burnt, and still point to the shadows on the moon's surface as being the scars which resulted from this execution. The *Mycoolon* blacks also explain the rising and setting of these luminaries, as well as that of the stars, by the supposition that they go beneath the earth through a hole, coming up again on the eastern side.

The evening star they have named *Yumby* which is their name for dog. The morning star is known as *Yaboroo*—bitch.

Orion's Belt, *Marbarungal*, they believe to be a great hunter who formerly dwelt amongst them.

The two dark starless spaces in the Milky Way are known as *Goonga*, and are believed to be two very old blacks who, a great while back, met their fate at Taldora on the Saxby River, where they were speared at a *Bora* meeting.

Two "black clouds," near the Southern Cross are named *Innkerberry*—the emu.

They occasionally hear a report at the time of a falling star: this they have named *Goonbor*, in allusion to a game in which the black fellows carry one another and in which the bearer lets him that is borne fall, thus occasioning a noise.

The Pleiads are known as *Munkine*—the word used to express the idea of a maiden or unmarried girl.

The *Mycoolon* blacks have no name for a comet, the appearance of which they regard with dread.*

* With reference to the subject of the knowledge of Astronomy possessed by the Aborigines, much information may be gathered from a study of a paper on the subject by Mr. W. E. Stanbridge in the Transactions of the "Philosophical Institute of Victoria," Vol. II., pp. 137-40, Melbourne, 1857, (partly reproduced by Mr. Brough Smith, "The Aborigines of Victoria," Vol. I., pp. 432-4) the statements in which have

Whether the belief in spiritual beings, higher or lower, amounts to a religion or whether all forms of religion do not presuppose such a belief I am unprepared to discuss; but intercourse with the blacks for upwards of 25 years has led me to the conclusion that they are ever mindful of the moral obligations which such beliefs as those to which I have alluded impose upon them, and which are in great measure the guiding principles in the conduct of their lives; and that, degraded as they are, in their hopes and fears they are like other people in the world, and, moreover, Lang may not have been greatly in error when he concluded that they once enjoyed a higher state o civilization than that which they now present.*

His Excellency Sir Anthony Musgrave remarked at the conclusion of the paper that he was sure the members present felt much indebted to Mr. Palmer for his interesting remarks, and that the author had in them touched on a point on which he himself had laid some stress on a previous occasion (at the inaugural meeting of the society)—namely, the very general belief entertained by those who were best able to form an opinion on

been further systematised, with the introduction of many additional facts, by Rev. P. Macpherson (Proc. Roy. Soc. N. S. W., July, 1881, Vol. XV., pp. 71-75). More recently still this subject has been again dealt with by Mr. Peter Beveridge, in a paper read on 6th June, 1883, at a meeting of the Royal Society of New South Wales (Op. Cit., Vol. XVII., pp. 19-74) on the Aborigines inhabiting the Lower Murray and Lower Darling, in which special reference is made to this matter. These authorities have specially mentioned the ideas entertained by the blacks respecting the Pleiades, and have pointed out the coincidence which exists between their views respecting them and those of the ancient Greeks, as given by Smith (Dict. of Rom. and Gr. Biog. and Myth., Vol. III., pp. 411-12), and others.

* Those who wish to pursue this subject further will find much valuable information throughout Mr. Brough Smith's work, and especially in the chapter on Myths. (Op. cit. Vol. I., pp. 421-483.) Indeed I might have particularly referred to this authority in illustration of almost every fact which I have alleged.

the subject that our Australian blacks were not examples of the lowest class of men, and that there was good evidence for believing that they presented the result of a decadence from a much higher type of savage man than might at first thought have been supposed. He also stated that during his official residence in South Australia he had been in correspondence with the late eminent philologist, Dr. Bleek, who had invited him to collect what matter he could relating to the blacks, and that having done so, Dr. Bleek came to the conclusion, on grounds philological, that the Australian blacks were, linguistically, more closely related to the bushmen of South Africa than to any other savage people; and, moreover, that there was unmistakable evidence that they had at one time arrived in the development of their race at a much higher stage of civilization than that which they at present displayed. His Excellency further remarked that Mr. Palmer's statements afforded evidence of another kind in justification of such a conclusion, and were especially valuable as tending to promote inquiry on a subject which might well engage the attention of the Society.

THE RAINFALL AT BRISBANE AND INVESTIGATION AS TO ITS PERIODICITY:

COMPILED BY

B. WAGENKNECHT, Esq.

(Communicated by W. D. Nisbet, M. Inst. C. E.)

(Plates VI.—IX.)

Although I have the record of the rainfall at Brisbane for only a very limited number of years, viz., since 1860, at my disposal, I nevertheless have endeavoured to obtain with these limited data, by means of cycles and curves of periodicity, the probable rainfall for future years.

Plate VI. shows the amount of rainfall, graphically illustrated for the last 25 years, *i.e.*, from 1860 to 1884; the abscissæ representing the consecutive months, and the ordinates the respective amount of rainfall in each month. It will be seen on examination of this Plate that from January to March or April, respectively—the extent of the rainy season proper—the amount of rainfall is invariably a maximum as compared with the remaining months, and from May to September an average minimum; whereas from October to December, according to the frequency of thunderstorms, a mean between the both is experienced ranging from 1″ to 10″ in October, 1″ to 8″ in November, and 2″ to 13″ in December. Although, however, one can see at a glance which year was more or less blessed with rain and at what time of it, Plate VI. is not suitable to demonstrate a periodicity of wet or dry years. For this purpose Plate VII. has been prepared, as affording a clearer insight; and in this the ordinates represent the amount of rain in each year, the baseline-divisions answering to the respective year in which it fell. It will be observed, on reference to this, that on an average every third year has a maximum of rainfall, the two intervening years being more or less dry; and again that every third of those maximal rainfalls (*i.e.*, every 9 years) a culminating point of the curve occurs, in which the rainfall during those 9 years arrives at a maximum, as in the years 1861, 1870, 1879 and probably 1888. In connecting all these prominent points or maximal rainfalls by a line, undulating curves of similarity are obtained, which go to show that those intervening cycles of three years are gradually more deficient in rainfall the more they recede from a maximal or culminating point of the curve, and gradually augment again their rainfall the nearer they approach the next point of culmination; so that 1861, 1870, and 1879 were blessed with abundant moisture, whereas 1863, 1867, 1872–73, and 1875–76, although not quite so abundantly blest, were also wet years; furthermore, according to the 9 years' cycle, the years 1872+9 or 1881, and 1876+9 or 1885, should have proved moderately wet years. As far as the year 1881 was concerned, this was true, but not so for 1885, as I will hereafter explain.

As regards the minimal rainfalls, I find that their cycle is also 3 years, so that roughly speaking two wet years and a dry year are following each other periodically; and furthermore, that those dry years increase in intensity the more they recede from their point of culmination as a minimum, and also decrease in severity the more they approach the next point of minimum-culmination. By connecting all the ordinates of those years which proved to be dry with a curve, as also shown [BY A DOTTED LINE] on Plate VII., I obtained a distinctly marked undulating periodical curve of 15 years cycle, so that, according to the figure, *maximal* or *disastrous* droughts appeared in 1862, 1865—and in 1862+15 or 1877, and 1865+15=1880-81. We therefore may expect the next disastrous droughts in 1877+15 or 1892, and 1880+15=1895.

Before I enter into the disturbance of my curve during the years 1881—1885 I will draw attention to Plate VIII. which represents the cycles by closed, instead of continuous curves as before:—The cycle or circle is divided into nine equal parts by radii, and the amount of each year's rain is expressed in polar-co-ordinates at $\frac{1}{20}$ scale. The cycle marked (— — — —) represents the 9 years from 1860 to '69; the second or cycle marked (- - - - - - -), those from 1869 to '78; and lastly, the third cycle (———), those from 1878 up to 1884. All of these cycles close wonderfully well in the years 1860, 1869, and 1878. As will be seen, each curve has three prominences and three depressions at nearly the same cyclar year, so that maxima of rainfalls occurred in the years 1861, 1870, and 1879; furthermore, in 1864, 1873, and also 1882 moderately, and lastly in 1867, 1876, and—should have occurred—in 1885. On the other hand, minima of rainfalls occurred, according to the depressions of the cyclar curves, at the years 1862, 1871, 1880; also in 1865, 1874, and 1883, and lastly in 1868 and 1877. Both these curves show great similarity, and so partially the one marked (———); but from 1881 up to 1884 this last has experienced some decidedly depressing influence, which put it out of shape and minimised the rainfall in 1882, also considerably in 1881; but augmented it in 1880, and slightly in 1883, and it has all appearance that it will be further distorted by the year 1885—in which year the rainfall ought to reach the total of 58 inches. In the same way as this cyclar curve has been disturbed, so has the continuous curve on Plate VII. been broken up rudely during the above mentioned years by some unknown agent. This may be the same agent that caused such disastrous floods and terrible earthquakes in one part of the globe; and severe continuous droughts, a red glowing sky and quite unseasonable rains in strictly tropical countries, or regions, in another part. May not the recent conjunction of our fellow-planets, which extended over those disturbing years, have had its influence upon our meteorological conditions also? Why is that part of the third cycle, namely from 1881–5 so rudely stamped, when its fellow-cycles enjoy harmonious continuity to a marked degree?

However, I expect that, from 1886 up to 1890, four years of abundant rainfall will alternate with short and uninjurious dry periods, for both maximum and minimum curves on Plate VII. have a tendency to reach their respective culminating points in 1888.

I now come to the most important part of my researches, namely an attempt at determining approximately the rainfall for each month of the year. For this purpose I have prepared the different figures in Plate IX. showing cycles of 19 years duration—one cycle for each month of the year. The cycle marked (———) represents the amount of rain for the first 19 years, during the same month of each year, namely from 1860 to 1878, and the second or curve the new (- - - - - - - - -)

cycle, namely, from 1878 to 1885. The first and second cycles coincide in most months, as for instance January, April, May, July, August, September, and October very fairly. But, unfortunately, the limited number of years of observations at my command, coupled with the length of their cycle, which as stated is between 18 and 19 years, leaves me no chance to complete the second or a third cycle to correct and establish their mean cycle. However, for this and the ensuing year of 1886 the rainfalls of the several months of the year should, according to my cyclar curves, approximately be as follows :—

	year.	inches.
October	1885................	4
November	,, ...	1
December	,, ...	3
January	1886	7
February	,, ...	6
March	,, ...	$5\frac{1}{2}$
April	,, ...	14 (a flood likely)
May	,, ...	1
June	,, ...	$\frac{1}{2}$
July	,, ...	5
August	,, ...	no rain
September	,, ...	$1\frac{1}{2}$
Total inches of rain for the 12 months		$48\frac{1}{2}$

As in the previous cyclar curves on Plate VIII., so in these monthly curves from the year 1880 to '85, tendencies to fluctuate are very noticeable, remarkably so in January, February, March, June, July, August, November and December; but I anticipate that in future years those violent fluctuations, though *within* the precincts of the cycle, will cease and cling more closely again to the contours of the previous cycle, so as to enable me to predict within reasonable limits, the meteorological nature of each month of the ensuing year.

Should encouragement and facility of obtaining data be offered, I intend to determine those cyclar curves also for our strictly tropical coastal, as well our inland main stations, so that those periodically re-occurring disastrous droughts may be forecast and provided against.

ON REMAINS OF AN EXTINCT SAURIAN:

BY

C. W. DE VIS, M.A.

PLATES X.—XV.

AT an early stage of our knowledge of the post-pliocene fauna of Queensland it became evident that aquatic reptiles, huge in their generation, were among the more frequent of its constituents; great turtles were found to have inhabited the waters of the area now occupied by the Peak Downs, and saurian teeth, first observed by Stutchbury in the central districts, were collected by Daintree from Diprotodon breccia of the north. But important as was this evidence, that the permanent waters, and the climate of the post-tertiary period, were fitted to sustain bulkier reptiles than do those of the present, and potent as it was in teaching us to find without surprise, in other parts of the bone drifts, saurian remains mingled with those of the giant marsupials—it went no further. It hardly engendered, certainly did not warrant, an assumption that the fossil saurian is extinct in Australia, or in other words was not the same with one or other of the two now living there. True, its teeth, larger than and dissimilar to those of the present fresh-water crocodile so-called, were found associated with fresh water shells; but, as we know, the great crocodile of the coast frequents our river channels far above tidal influences and even wanders into adjacent lagoons. Indeed, from the fact that these reptiles have a longer specific life than animals more highly organised it might have been almost inferred that the old would prove to have been the direct progenitor of one or other of the recent crocodiles; at any rate, the most we had a right to expect was that it might be specifically distinct. If then it should ultimately appear that the fossil animal was so different to both the living ones, as to require us to place it in a distinct and geographically remote family, it comes before us with enhanced interest—enhanced, not so much by the bare fact as by the bearing of the fact on the geographical distribution of life in the past as compared with that in the present age.

Every part of the Condamine drift which has been searched during the last two years at intervals, by the collectors attached to the Queensland Museum, has been found to yield traces of crocodilian life. Teeth and scutes have occurred invariably and in moderate profusion—vertebras also, but in comparative paucity: limb-bones with still less frequency: while rarest of all, until lately, have been the parts most needed as guides to the relations of the quondam owners with the indigenous members of the order now living. Portions of skull were indeed amongst the earliest of these relics to present themselves, but, they appeared in fragments so far characterless as merely to whet the suspicion already formed by the structure of the dermal scutes, that the near affinities of this saurian were not altogether the same as those of the members of the order now inhabiting Australia. Recently, however, more instructive cranial and mandibular fossils have been met with, and it may now be no longer premature to invite attention to the evidence they give in favour of two conclusions—first that the saurian member of the past fauna was not identical with either of the two crocodilians in the present one; second that it was not even nearly allied to them.

Of the bones of the skull, with which the present communication mainly deals, the latest and most useful acquisition is that which forms the subject of Plate X., Fig. 1.

THE ANTERIOR HALF OF A YOUNG LOWER JAW.

The salient feature of this fossil is its predominant breadth at the symphysis, the length of which is considerably less than the space between the inner edges of the sockets of the canines. In the fresh water species named by its first examiner *Crocodilus johnstoni*, and subsequently referred to several other genera, the symphysial length is more than twice the distance between the *outer* edges of the same sockets; it is nearly equal to that same distance in the young *C. porosus*, but in the adult jaw of the littoral species it is relatively shortened by the lateral expansion attendant upon the dilatation of the maxillaries during growth: yet even here it is equal to the distance from the outer edge of one alveolus to the middle of its fellow of the opposite side.

In the fresh water *johnstoni*, the width of the mandible at the fourth tooth equals its length from the tip to the hinder edge of the third socket; in the young *C. porosus*, to that of the fourth, and in the adult of the same species to that of the fifth socket. In the fossil it extends backwards to the centre of the seventh.

The symphysis in the living species of the tablelands, *johnstoni*, ends opposite to the hinder edge of the sixth socket—in the salt water reptile, old and young, opposite to the end of the fifth. In the fossil it attains the level of the posterior third of the fifth alveolus, but at the same time exemplifies the vagueness of this mode of indicating the proportions of the symphysial region; the more rounded muzzle of the fossil species is absolutely much shorter, though relatively to the dental series but little shorter, than the comparatively pointed chin of the adult *C. porosus*. Keeping in view the immaturity of the present subject, it may be said to exhibit a shorter and more expanded snout than any of the crocodilidæ. In this feature it reminds us rather of the American alligators, Caiman and Jacare.

Of the sockets posterior to the notch, the tenth is distinctly the largest; it is however nearly equalled in size by the eleventh, and the latter is, as in *johnstoni*, much larger than the ninth. Bearing in mind that in the crocodiles and the alligators the eleventh lower tooth is the largest, we must recognize in this character of the fossil species a mark of divergence from both of the great recent families with which it can possibly be compared.

Seeing that this mandible has nothing in common with that of a gavial, it is almost needless to say that the splenial does not enter into the symphysis

EXTREMITY OF THE LEFT MANDIBLE OF AN ADULT.

(NATURAL SIZE.)

PLATE XIII.

It is evident that no increase in the width of the symphysial region, as obtains in C. *porosus*, took place during the growth of the post-pliocene reptile, since, in this subject, the proportions of the young mandible are strictly preserved. The side of the notch presents a well marked groove for the reception of the upper fourth tooth, and behind it a similar impression apparently due to the action of the fifth. These lateral grooves are probably a character of old age, since they are not found in an adolescent mandible, nor in the subject of Plate X., Figure 1. The sixth tooth, in place but imperfect, is remarkably small, its diameter being but little more than half that of the seventh socket. So great a difference in size between these teeth may be abnormal or senile—it does not exist in the younger phases of the jaw.

ARTICULAR REGION OF RIGHT MANDIBLE, ADULT.

(NATURAL SIZE.)

PLATE XII.

The most obvious characters of this bone are the breadth and flatness of the upper surface of the surangular, and the great development of a ridge descending forwards upon the angular from the outer tubercle of the surangular; commencing with that tubercle, which itself is of much greater size than in a large C. *porosus*, it forms a continuous and nearly smooth boundary to the deeply sculptured surface of the surangular: subsiding as it approaches the angular-surangular suture it immediately recommences below it, and at about half of its course, interrupted by the fracture of the bone, it attains a height of twenty-five mm. above the general level. This ridge is but faintly marked in the adult C. *porosus*. On the other hand, the sinuous groove conspicuous in the latter reptile below the ridge is in the fossil scarcely observable. Neither ridge nor groove is present in the feebler species of the fresh water.

The angular-surangular suture preserves a straight course without any flexures. The upper surface of the surangular is 28mm. in breadth (in another example 37mm.), flat and angular on both edges, the angularity increasing with age. The hinder part of its inner edge, however, rises into a low elongated tubercle which adds to the depth of the antero-exterior wall of the articular cavity. Apart from such increase the cavity is deeper than in crocodilus. The posterior lip of the articular cavity, of which about half is preserved, is nearly straight and level; the buttress behind it rising from the articular slopes gradually and equably towards the nearly flat, upper and posterior surface of the bone without forming on its exterior angle a strong convexity, dipping suddenly into as strong a concavity, behind it as in C. *porosus*, or developing more than a faint trace of the mesial ridge which, in the latter, separates the outer from the inner tracts of the articular. From the outer tubercle of the surangular its posterior edge descends rapidly, so that, at the fracture of the bone, it is reduced to a depth of 14mm.; on the inner surface of the fossil the angular-surangular suture is seen descending forwards with a very oblique course.

From a second, and as far as regards the articular cavity, perfect example of this part of the mandible we learn that the thickening and flattening of the upper surface of the surangular is an effect of age, and that the post-glenoid surface of the articular piece is at an early age concave both transversely and longitudinally, and is divided by a mesial ridge which is seen commencing faintly far beyond the lip of the cavity.

LEFT PREMAXILLARY OF AN ADULT.
Plate XI., Fig. 1.

The present subject yields frequent proofs of the non-identity of the fossil reptile with either of the existing species of crocodiles, but less certain information respecting its affinities. By the fracture of the lower surface of the bone we are deprived of the opportunity of tracing the exact course of the maxillo-premaxillary suture, so important as an aid in the classification of the crocodilia. The suture, however, is distinct on the edge of the fracture, midway between the longitudinal palatine suture and the notch, and yet nearly opposite the notch, therefore its direction could not have had much, if any, convexity caudad as in most of the crocodilidæ; but whether it were straight or convex forwards is more than we can gather. The suture may be traced somewhat dubiously to the foramen opposite the notch, from that point outwards and upwards it is totally obliterated. On the upper surface the bone has been partially separated by disarticulation, the edge of the resulting sutural surface leaves that of the external nares at a very open angle, and is but feebly convex backwards. There is no sign that the nasal bones entered into the external narial aperture; both the external nares, and the anterior palatine foramen appear to have been situated far back on the snout, and the shape of the former subcircular, and much wider posteriorly than in *C. porosus*. The notch is entire, neither perforated nor emarginated on the edge; the anterior two teeth with their sockets are broken away; behind and between the third and fourth is a large and deep pit and, in the same relation to the fourth and fifth, another shallower, while at a corresponding distance from the edge of the notch is a still smaller but better defined one ; these cavities may perhaps be due to the action of the mandibular teeth.

PORTION OF HINDER PART OF MAXILLARY.

PLATE X., FIG. 2.

We have in this well-worn fragment further evidence almost of itself sufficient to convince us that the fossil reptile was, in the broad sense, an alligator. Within and between the stumps of the three broken teeth are three well-marked pits for the reception of the hinder mandibular teeth. Those of the crocodilidæ pass not inside of, but between the teeth of the upper jaw.

LEFT MALAR, ADULT.

PLATE IV., FIG. 1.

The characteristic features here are—first, the flattening and extension of the inferior edge inwards at right angles to the lateral surface, the expansion forming a triangular area with its apex entering the junction of the maxillary and ectopterygoid sutures. The pitting of the facial surface is continued over the greater part of this area. Second, the presence of a deep suborbital groove commencing superficially opposite the post-orbital process and dividing the broad and boldly sculptured edge of the orbit from the rest of the bone. In the massively angular character of the skull and mandible suggested by this bone and by the surangular element, we have a further reminder of its condition in the caiman.

PREFRONTAL REGION.

PLATE XIV.—FIG. 2.

In the adolescent stage exemplified by this fragment, the interorbital space is quite flat and devoid of transverse ridge. At about the middle of the anterior half of the edge of the orbit a broad groove commences on each side and diverging from its fellow, runs forwards over the fore-end of the lachrymal; the anterior extremity of the frontal is depressed by the commencement of a third and mesial groove which widens and deepens as it enters the furcation of the nasals. The rudiment of a preorbital ridge occupies the orbital part of the lachrymal, and adjacent angle of the prefrontal—but there is nothing to testify clearly that it does not recommence below its apparent termination. Assuming the alligatorian relationship of the animal, we are by this fossil once more directed towards caiman as its nearest kin among living forms: jacare being eliminated by the absence of interorbital, and alligator by that of preorbital ridges.

CONDYLAR PORTION OF TYMPANIC, ADULT.
PLATE XI., FIG. 2.

By the form of the condyle alone we should be justified in separating generically, if not sectionally, the extinct from the living species familiar to Australian observers. The outer limb of the condyle of *C. porosus* is strongly convex and considerably broader than the inner, and the ligamental pit is anterior to the fore edge of its lip. In *C. johnstoni* this limb is less convex and its breadth is equal to that of the inner; the ligamental pit is in the middle of its surface. The convexity of the outer limb of the fossil condyle is comparatively feeble in both the transverse and fore and aft direction, its surface is indeed flattened near the central ligamental impression; it is also much narrower than the inner limb, which has consequently the larger instead of the smaller share in the articulating surface. The bone is of greater length, posteriorly to its junction with the exoccipital, than in either of the recent species—its length is equal to its breadth, whereas in *C. porosus* the length is three-fourths, and in *johnstoni* but two-thirds of the breadth.

TEETH.
PLATE XIII.

The slender sharp-edged teeth, of nearly uniform size and shape, of the gavials contrast forcibly with the stout rounded and differentiated armature of the other two families. A glance at the sockets in the fossil jaws, and the numerous teeth scattered through the drift, will convince us that the species represented by them belong to one or other of the predominant members of the order; not only do the teeth vary greatly in size and position conformably to those of crocodiles, but they afford sufficient evidence that their form in the hinder part of the series was almost the same as that distinguishing the posterior from the anterior teeth of living crocodilia. It is, however, remarkable that these teeth with constricted crowns and short lobes are exceedingly scarce—they number three per cent. only in a collection of 450 specimens of all ages. It is difficult to believe that this paucity is altogether accidental, it would indeed be preferable to infer that not more than one or two teeth on each side took on this character, which in *C. porosus* is a character of immaturity.

EXOSKELETON.

Plate XV.

Students of past life are indebted to Professor Huxley, for the observation (Proc. Lin. Soc. Lond., iv., p. 21) that in two of the genera of alligatoridæ, Caiman and Jacare, the lateral edges of all the scutes of the dorsal and ventral shields are united by serrated sutures, and the anterior end of the outer face in each is provided with a well marked smooth facet, which is overlapped by the smooth under surface of the scute in front of it; while in alligator, the crocodiles and the gavials, the edges of the scutes, except those of the two median longitudinal rows, are hardly ever united by sutures, and there is no flat bevelled articular face on the outer surface of the anterior margin of a scute for articulation with its predecessor. Of the fossil scutes, to be interpreted by the light of this statement, five kinds may be distinguished—the *first* quadrangular in shape with the lateral edges serrated, the fore edge bevelled and forming a distinct articular plane of variable width, and with a more or less elevated mesial crest; the rectangular form and the presence of the crest shew these to be dorsal scutes; they constitute about forty per cent. of a total of more than one hundred. The *second* kind differ from the first only in the absence of the crest, and in consequence may fairly be presumed to be abdominal scutes; they are about thirty per cent. of the whole number. *Third*, cervical plates represented by two triangular and crested scutes facetted on one edge, and not suturally serrated on the others. *Fourth* cervical plates, triangular and cristate but without articular facets and sutural edges; these are pretty frequent. *Fifth*, pectoral plates, irregular in shape and non-articulate: fewer than the last.

Relying on the results of Professor Huxley's investigation we cannot but recognise in the distinctly imbricate and sutural characters of seventy per cent. of these scutes, evidence of the alliance of their quondam owners with the alligatoridæ; and should further discovery confirm the supposition that those of the second group belong to the abdominal region, the probability that the extinct Australian was closely related to the living genera of tropical America will be almost assured.

However this may be, no doubt remains that the fossil species was one distinct from the Indo-Australian, and probably ecdemic, *C. porosus* on the one hand, and from the saurian peculiar to our northern tableland on the other. It may, however, be remarked that on the evidence of the scutes *alone* there is less difference between the extinct and the extant fresh water forms than between the latter and the true crocodiles.

To sum up the evidence before us, it appears that the portions of skull examined do not in their imperfect condition present a combination of family characters exclusively alligatorian, nor on the other hand distinctly crocodilian; but that if we allow this seeming equilibrium of testimony to be disturbed by the weight derived from the imbrication of the scutes, the beam must sink at once on the side of the American family.

Provisionally it is a conclusion of some interest if only that it adds another to the curious facts recorded in the history of the procælian crocodilidæ. For this past member of the alligatoridæ, if such it be, the writer does not propose a generic name; his acquaintance with the literature of the tertiary and post-tertiary crocodilidæ, does not suffice to assure him that it can not enter into any known genus. To assign to it a generic name must be the privilege of some one better informed. The cabinet name, Pallimnarchus pollens, appended to it in the Queensland Museum, is merely one of convenience.

EXHIBITS.

Besides the objects introduced in illustration of the papers by their respective authors, Mr. J. Thorpe exhibited a chart, showing a copy of the register of a self-recording aneroid barometer together with the distribution of pressure over Australia daily for the month of October, and made several comments on the same.

FRIDAY, DECEMBER 4, 1885.

THE PRESIDENT, L. A. BERNAYS, ESQ. F.L.S. ETC., IN THE CHAIR.

ANTHROPOLOGICAL SECTION.

The Hon. Secretary announced on behalf of the Council that an Anthropological Section had been opened, and invited applications from those willing to join it.

NEW MEMBERS.

Mr. W. H. Moore, of Sandgate, and Mr. B. L. Barnett, Mr. G. Simkin, C.E., and Mr. A. W. Clarke, of Brisbane.

LIBRARIAN.

Mr. H. H. A. Russell was appointed to the position of Librarian, on the recommendation of the Council.

DONATIONS.

"The Victorian Naturalist," Vol. II., No. 7. Melbourne, November, 1885. From the Field Naturalists' Club of Victoria.

"Proceedings of the Canadian Institute," 3rd Series, Vol. II., Fasc. 1, 2, 3, and Vol. 3, Nos. 1 and 2. Toronto, 1884–5. From the Institute.

"The Provincial Medical Journal," Vol. IV., No. 46. October, 1885. From the Editor, Leicester.

"Report of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia for 1884–5. Adelaide, 1885. From the Public Library, Adelaide.

"Russkago Geographicheskago Obshtchestva." Transactions, Vol. XXI., Pt. 3. St. Petersburgh, 1885. From La Société Imperiale Russe de Geographie.

"The Australian Irrigationist," No. 16. Melbourne, November 26, 1885. From the Editor.

FORBES EXPEDITION AID FUND.

The President drew attention to the fact that Mr. H. O. Forbes, F.R.G.S., was now prosecuting his researches in New Guinea under some difficulties, owing to a lack of adequate support, and enlarged on the claims of his expedition to public patronage. A subscription list was accordingly opened at the meeting on behalf of the explorer, and the Hon. Secretary was appointed treasurer of the funds raised in furtherance of the movement.

The following papers were read :—

NOTES ON A GREAT VISITATION OF RATS IN THE NORTH AND NORTH-WESTERN PLAIN COUNTRY OF QUEENSLAND, IN 1869 AND 1870.

BY

E. PALMER, M.L.A.

In the case of feral animals, the number of a particular kind frequenting any one spot seems to be subject to periodical variation. It is as if the latent force of over-reproduction, inherent in the lower forms of animal life, only demands that the checks be removed or loosened, and when this has happened immediately the power asserts itself. In illustration of this statement I will describe what, in so much as it has happened recently, is perhaps well-known to many, the extraordinary and sudden increase in numbers of an indigenous rat in the western and north-western plains, from the heads of the Flinders and Cloncurry northwards, in the years 1869–70.

Where these rats came from is a mystery. About the middle and towards the end of 1869 they were first noticed; principally by the action of the black-boys in going out on the plains and bringing in scores of them, in an hour or two, for roasting as food. January and February, of 1870, were months of continuous rain, ending in the largest floods ever known—the waters covering the country for many miles.

As a result of this exceptional season of 1869–70 there was an exuberance of vegetation generally, and the presence of the pea-bush, (*Sesbania ægyptiaca*), all over country where it had not been known before. This plant attained to a height of eight to ten feet, and grew so close that it was almost impossible to make one's way through it; indeed so dense was it that frequently the leaders of a team could not be seen from the waggon. The stock were uncommonly fond of and fattened on it. The flowers were both yellow and lilac. After a few months the stems dried and the plants fell.

Moreover, immediately after the waters, occasioned by the excessive rain, had subsided, the plague of rats increased to an extent that would scarcely be credible. They covered the plains in every direction; when riding at night they could be heard squeaking everywhere fighting with each other; they swarmed into the huts and gnawed everything they could get at. Flour, meat, and leather articles had to be stored in galvanized iron rooms or safes, built expressly for the purpose. When camping out, every article had to be hung in a tree, and the hobbles, made of green hide, have been known to be gnawed off the horses feet during the night. Dogs and cats got surfeited with these rodents and at last took no notice of them; if a hundred were killed round the hut at night there appeared no diminution of the number of visitors on the following night; and for months in succession the same slaughter could be kept up. It would be impossible to estimate numbers; for hundreds of miles along the Flinders and its tributaries traces of these rats were to be seen; the grass looked as if it had been cut down, or flocks of sheep had been over it; saplings of white-wood (*Atalaya hemiglauca*) six inches in diameter were bitten through, and the bark of other trees gnawed off. Fifty thousand square miles occupied by these animals, and one rat to every ten square yards in each mile would not represent anything like their numbers. The large open plains appeared to be their favourite resort, and, strange as it may appear, very seldom were any young ones discovered, although their nests were occasionally found, showing that they bred in the country.

Towards the end of 1870 they decreased in numbers, and in the following year disappeared. Had the rats continued to multiply or even maintain their number, the country would have been uninhabitable; even as it was, while the plague lasted, they were a source of great annoyance and loss to the settlers.

The rat, whose description seems most nearly to approach that of this indigenous rat, is the brown rat (*Mus decumanus*), said to be imported into Europe from the north of Asia. It is similar also to it in its habits, being a ground animal given to burrowing, wherever it cannot appropriate any burrows or cracks already made. It is of a greyish brown colour, not much more than six or seven inches long in the body, with a short thick bare tail three inches long; the fur is close and short, the body thick and strong, the ears short and stiff. These rats are nocturnal and omnivorous, at times even carnivorous, very partial to fat or meat, and even devouring one another.*

As a consequence of such an abnormal state of things as the sudden increase in numbers of a particular animal, changes are also produced affecting other animals associated with them in the same district. The balance of nature has to be kept in some way or other; and if a race of animals increases at a very rapid rate, unless disease checks its growth, another race to prey upon these will appear on the scene; so it was in the present case. In conjunction with the increase of rats, an almost corresponding increase in their natural enemies—native dogs, snakes, hawks, and owls occurred. Snakes became very numerous, a large brown snake in particular was to be met with any day

*This rat of periodical occurrence is not to be confounded with another animal which is a permanent resident of the country, and known as the bushy-tailed "rat." This is a much more interesting little fellow, a lively, handsome, delicate formed animal, with erect rounded ears and wide spreading whiskers. The fur is softer, the eyes large and more expressive, the whole animal smaller with the exception of the tail, which is longer than the body, and ends with a tuft or brush of long black hairs. It is essentially a climbing animal, and very rapid in all its motions. It comes into the houses and sometimes makes its nest in a box of books or clothes, cutting everything to pieces. Moreover, it is not very common nor anywhere numerous. Both of these varieties of so-called rats seem to be indigenous to Australia, as they are familiar to the blacks, who, however, recognize the difference between them.

on the plains in scores, resorting to the deep cracks or fissures for hiding places. These snakes could follow the rats into their nests, and there was no escape from such an enemy; owls were always plentiful, and very active agents in destroying the vermin.

Almost simultaneously with this visitation of rats, an extraordinary flight of grasshoppers passed northwards in a compact body about a mile in width and occupying a whole day in passing. These insects altered the look of the country over which they passed, and so great was their number that at night the branches of the trees on which they rested were broken down by their weight. Their daily stage was three to four miles; and they left nothing green in their line of march.

There was evidence that the same country had been subject to a similar visitation years before—in the fact that hollow trees, in which owls had lived for years, were filled with the bones and skulls of millions of rats; and great heaps of such remains lay around the base of some of these large old hollow trees, when the settlers first occupied the country five years before the occurrence now related.*

It is also interesting to notice that other countries have suffered in a similar manner. In the *Gazeteer* of the "Bombay Presidency," there is a description of rat plagues in Ahmednugger, a district north-west of the Hyderabad State - of an area of 6,666 square miles, and a population of 751,228. "This district is subject to visitations of famine and other calamities, of which the most striking and singular is the plague of rats. Generally the rainfall in June suffices, by filling the holes and fissures, in destroying them in large numbers and preventing a plague. But when the rain is late or does not come, then the number of rats is always excessive. In the last

* Instances are not uncommon of parts of Australia "being subject to an infliction of over-production in animal life;" amongst others it is reported that Cooper's Creek, and the far western country, were visited many years ago by multitudes of mice—a visitation similar, in point of numbers, to that of the rats in the Gulf Country.

sixty years three have been known as rat years. These were 1826, 1835, and 1879. On the last occasion, fields of grain were eaten up in a few hours as if by a flight of locusts. A reward of one rupee, reduced at a later period to half a rupee, was offered for every hundred dead rats, and it was estimated that not fewer than 1,768,000 rats were killed and paid for. Although the people were the sufferers, popular superstition does not seem to have approved of this slaughter, for reports were spread that the rats were the spirits of those who died in the famine of 1876-7, and the people refused at last to participate in the efforts made for their extermination. Locusts and famines have proved scarcely less formidable to the agriculturalists of 'Ahmednugger' than rats."

The question arises: What causes contributed to the production of such a sudden development of animal life, and as suddenly almost to its extinction? The generally received opinion is that the increase of rats was due to congenial surroundings, shelter in the natural cracks of the plains, exuberant herbage and an unstocked country—coupled with a then scarcity of their natural enemies; even the tribes of blacks* had withdrawn from the plain country and occupied only the mountainous parts, hundreds of miles away. This may account for the rapid increase of the rats on the Flinders River; but the opposite reason is given in the case of the rat plague in Ahmednugger—where, if the rain does not come in June, or fails—the rats become excessively numerous, and spread over the country. The two reasons point to similar conclusions, though from opposite views.

Their disappearance is not so much a mystery, and can be accounted for by various considerations. Increase of their natural

* Where marsupials have increased beyond nature's limits, it can be shown that this is due to the fact that the disturbing influences of the Aborigines and dingo having been removed, the race has room to develop unchecked.

enemies, the dryness of the grass and herbage towards the end of the season, and their own voracity—leading them to devour each other at all times and more particularly when pressed by hunger. This is a propensity that all the rat tribe are given to, and is no small factor in decreasing the numbers under such circumstances as I have narrated.

THE ESTABLISHMENT OF A GEOLOGICAL SURVEY IN QUEENSLAND;

BY

R. C. RINGROSE, M.A.

The object of the present paper is to point out the practical and scientific value of an organised geological survey for the colony of Queensland. In doing this the writer proposes to sketch very briefly what has already been done in the investigation of the geology of the colony, and to introduce the whole question of the value of a systematic study of the science of geology in a colony as rich in mineral wealth as this is, and to show that in most civilised countries the value of a permanent geological survey is recognised. The aim of the paper is chiefly suggestive, and his object will have been gained if it can result in such a discussion of this matter, as will lead to the permanent establishment, by the Government of this colony, of a regular geological survey. Moreover, a question of this nature is one which the writer ventures to think may be very well brought before this Society and discussed, as it involves the whole future of a branch of science which is more likely to prove practically useful in a colony like this than any other.

It would be beyond the scope of this paper to enter into the whole question of the scientific value of the study of geology, and it will therefore be assumed. It will be enough to state that the Governments of nearly all European countries, and of the United States, and of most of the British colonies have recognised its importance by establishing a permanent survey. The English geological survey has long been established, and now a very large portion of the work has been completed. The staff of the survey consists of the large number of 57 skilled persons. They include a director-general, 3 directors, 3 district surveyors, 14 geologists, 25 assistant geologists, 4 naturalists and palæontologists, 4 fossil collectors, and 3 general assistants.

The permanent geological survey of Canada was commenced many years ago, and since that time it has continued to do valuable work. (Prof. Bonney, the President of the Geological Society of London, in a recent speech at the Colonial Institute, referring to their work, said, that he thought, considering the vast area of country to be gone over, and the difficulties of many parts of it, it was wonderful that they had accomplished so much. He urged that some specialist should be added to the present staff to whom the duty of prospecting minerals should be given, as it was impossible for the present staff to do that work without abandoning the more important scientific work of the general survey). The Geological Survey of Canada is directed by Mr. A. R. L. Selwyn, formerly in the service of the Victorian Government.

The colonies of New Zealand and Victoria have also got permanent surveys, that of the former colony especially has done a large amount of good work under the able leadership of Dr. Hector.

In New South Wales I believe there is as yet no permanent survey, although there is a staff of 3 or 4 geological surveyors. In South Australia it is said that they are about to establish a permanent geological survey. Altogether then, there is ample precedent for the establishment of a permanent survey here, and we are actually behind three of the leading colonies in not already having one. Although Queensland is the youngest colony of the group of the four most important Australian colonies, and it probably is the richest of the group in mineral wealth, yet the scientific survey of its mineral fields is very much behind in the proper investigation of their permanence and value.

At present, in Queensland, we have only two geological surveyors, Mr. R. L. Jack and Mr. W. H. Rands, the latter of whom has only been recently appointed. Perhaps I may be allowed to point out the great value of the work already done by Mr. Jack, who has without assistance surveyed the mineral fields of Charters Towers and district, Herberton, Hodgkinson, the Bowen River Coalfield, Little River Coalfield, Ravenswood,* Normanby Goldfield (south of Bowen), Mount Morgan Goldfield, besides taking part in an exploring expedition to the Cape York Peninsula, and in advising the Government on many minor fields which have not turned out to be of commercial importance. It is almost a matter of surprise that so much good work could have been done by one man under the circumstances, and with the frequent interruptions with which Mr. Jack has had to labour. It is to be regretted from a scientific point of view that his work has been carried out without a system, but under the circumstances that could not have been avoided by him. The fact is that Mr. Jack and Mr. Rands are employed as geological surveyors of mineral fields, and there is very little scope for them to do any pure geological work or even accomplish anything like a systematic geological survey of the fields on which they are employed.

Up to the year 1872 the geology of Queensland may be said to have been without any literature, because, although reports

* The survey of this field is not yet complete.

had been made by Mr. Aplin,* these reports only dealt with small districts and have remained buried to those who wished to study the literature of the subject. It is true there were observations on geology in the reports of some of the earlier explorers, and references had been made to the geology of Queensland by the Rev. W. B. Clarke and one or two others, but with these exceptions up to the year 1872, the year in which Mr. Daintree published his paper "On the Geology of Queensland,"† the geology of Queensland remained in darkness. In 1872 Mr. Daintree read this paper before the Geological Society of London, and his paper still remains the only attempt to deal with the subject as a whole. In it Mr. Daintree sums up all the observations of himself and other observers, and gives a general view of the geology of the whole colony with the exception of the Cape York Peninsula. Although many of the conclusions of Mr. Daintree will, no doubt, have to be modified, still this paper is likely to be the only source of information on the geology of Queensland for many years to come.

Since the date of Mr. Daintree's paper, almost the only worker, in geology at least, whose conclusions are accessible to the student, is the Rev. J. E. Tenison-Woods, who has published during the last few years several papers on the geology of both North and South Queensland. Amongst these are included papers on the Geology of North Queensland, the Hodgkinson Goldfield, the Wild River, Tin Mines in the north and south of Queensland, on fossiliferous beds at the Endeavour River, on the Burrum Coalfield, on Queensland Coalfields, as well as a paper published in the Proceedings of the Linnæan Society of New South Wales, Vol. vii., p. 95, on the "Fossil

* *Vide* "The Mineral Products of N.S.W., with Notes on the Geology of N.S.W., and Catalogue of Works on Australian Geology," by C. T. Wilkinson and R. L. Jack, Dept. of Mines, N.S.W.

† Q. J. Geol. Soc., Vol. xxviii., p. 271.

Flora of the Coal Deposits of Australia," which contains many valuable references to the coalfields of Queensland.

Mr. A. C. Gregory has published several reports on the geology of the south of Queensland, including reports on the coal deposits of West Moreton and Darling Downs, and the south-eastern portions of the colony. They contain a vast amount of valuable information. Mr. Gregory also published a map showing the area of the various formations in the south-eastern portions of the colony. These reports lay down the broad outlines of the geology of the district referred to, but since their publication a more detailed report has become desirable, owing to the rapid progress of settlement and the large development of the coal-mining industry in the neighbourhood of Ipswich. We have further a paper on the "Geology of the Stanthorpe Tin Districts," published by Mr. F. T. Gregory in the Q. J. G. Soc., Vol. xxix., p. 1. I have now summed briefly what has been done in this most important branch of science in this colony, and those who will take the trouble to refer to the various papers and reports of the above writers will see that, with the exception of the work done by Messrs. Daintree and Jack in certain districts, there is nothing like a complete survey of any of the districts referred to. So that, whilst we have a series of general observations and reports on various parts of the east coast of the colony, the proper observation and working out of geological phenomena, with the exceptions referred to, has not been effected.

It is my object to point out the practical value of extending the geological survey of this Colony, and, therefore, I shall lay much stress on its scientific aspects; but I may mention that there are many problems which, if worked out properly, would have at once a great practical and scientific value. I will take, as an instance, the case of the Ipswich coalfields, the proper and complete survey of which would at once have great value and throw light on a number of scientific problems at present very obscure. At present we are without information as to the extent and thickness of the Ipswich coal beds, their extension southwards towards the Logan, their relations to the coal beds of the Darling Downs and the Burrum. Such a survey is much desired by the mining managers and coal owners in the Ipswich district, and the probable result would be a very much more rapid development of the coal resources of the district. But there is also a scientific question of great interest depending on the investigation of these beds, namely, the examination of their plant and other fossil contents, and so the determination of the age of these beds. If this was done, light would at once be shed over the question of the position of the Australian coal beds in the geological scale, and the relation of the Australian series to those of India and Europe. On this question I will refer to an address delivered before the British Association last year, at Montreal, by Professor W. Blanford, F.R.S., of the Indian Geological Survey, in which he refers to the age of the Australian coal beds, and the remarkable discrepancies presented by the fossils as evidence of this age (see "*Nature*," vol. xxx., No. 775, p. 440).

It is a matter of regret that there are no proper surveys of many of our gold and mineral districts. Mining enterprise is at present far in advance of our geological knowledge of the mining districts. Many well-known mining fields have been open and worked for a number of years in this Colony, and yet the public are without geological reports on the nature and structure of the fields. I need only mention such well-known mining fields as Gympie, the Etheridge, Cloncurry, Ravenswood, Palmer, Wide Bay, and others of less importance. In many cases the want of knowledge of the existence of minerals has led to the alienation of Crown Lands by the Government, and by this means valuable mineral lands have been locked up, which, otherwise, would have been worked. I have been informed that this is the case more particularly in certain portions of the Wide Bay district. In other cases, a knowledge of the mineral resources of a district might have an important influence on the direction a proposed line of railway is to take. Instances of this are continually arising, and it is not at all unlikely that the question may arise in the Brisbane district when the time comes to make railways to connect Brisbane with the towns on the east coast. I refer to the existence of coal a few miles to the N. of Brisbane.

Another question, which is intimately connected with the geology of the country, is the question of water supply—a question which, at the present moment, is more important than any other. It is obvious that without water there can be no settlement of the country; but, more than that, it is an undoubted fact that in all countries the sites of large towns have always been chosen where there has been an adequate water supply. Profesor Prestwich* has pointed out that in London those suburbs which had a good supply of water from springs and wells, were the first to become settled. In the case of the London suburbs, as it is in all other cases, this water supply was entirely determined by the geological nature of the land on which they were built. It is clear that water supply, whether it is in the shape of rivers or springs or lakes, must in all cases depend on the geological nature of the country. It would be beyond the scope of the present paper to discuss the various laws which regulate the course of rivers or the flow of water below the ground, but it may be as well to point out upon what data a systematic study of the question of water supply must depend.

It will be necessary then, in the first place, to have complete and accurate records of the rainfall over the whole colony. Having obtained these records, the question then arises—What

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* *Vide* Address of Professor Prestwich to Geological Society of London. —Q. J. G. Soc., 1872, p. 53.

has become of the water? This question resolves itself into two:—

1.—This relates to the supply of water above the ground. How much water is carried away by rivers or streams, or stored in lakes, in any given area of natural drainage? This question then becomes one of physical geography, which is, of course, intimately connected with the geology of the country. Now, in order to deal with the question, it will be necessary to map out the colony and determine the areas of natural drainage—a subject which still requires to be worked out. The country would then have to be divided into natural districts showing the water system. I may say that this has already been done in England by the Water Supply Commission, and in a colony like this where the greater part of the land is still unsettled, I maintain that it is the duty of the Government to be able to give the fullest information on this head.

2.—The question of the underground water supply. This is a much more difficult one, but not less important, for we see that in seasons of drought like this, whole districts are depending on underground water supply. Now this part of the question depends entirely on the geology of the country. Engineers admit that for information relating to underground water-supply they must rely on the work of geologists. It is for engineers to get and store the water when they have been shown where the areas for sinking exist. The supply of underground water must depend entirely on the nature and structure of the rocks. I cannot do more in this paper than refer to the various reports of the Committee on Underground Water Supply, published by the British Association; to several papers by Mr. Abbott, in the Proceedings of the Royal Society of New South Wales; to the account of the Water Supply Conference in England ("*Nature*," August 14, 1884, vol. xxx., p. 375), and more especially to a statement in a paper by Mr. H. C. Russell,*

* Proceedings Royal Society New South Wales, vol. xvii., p. 129.

Government Astronomer New South Wales, concerning the River Darling and the water which should pass through it. Mr. Russell there gives an estimate of the water, based on rainfall statistics, which should be carried away by the Darling River, and also of the quantity of water which actually does pass through the Darling River. The conclusion, which Mr. Russell arrives at, is that a very large portion of the rainfall of the basin of the River Darling must disappear beneath the surface.

In England, owing to the increasing importance of the water question, the Geological Survey have commenced to mark on their maps the areas covered by drift deposits distinguishing these by different colours, so as to show the permeability and impermeability of the various surface deposits. A geological survey here in Queensland, by unravelling the structure of the country and marking on its maps the places where water-bearing rocks exist, would show the broad features of the underground water system, but the complete working out of this problem can only be effected by a long series of observations and inquiries

I have now briefly sketched what has already been done to elucidate the geology of this colony, and I have also pointed out what I believe to be the most pressing wants at the present time in indicating that the direction in which future work in the domain of geology should be conducted, is in the completion of the geological surveys of our mineral fields, and the investigation of the geological structure and rocks of the colony, so that light may be thrown on the question of water supply. In urging the completion of the surveys of the mineral fields, I would insist that not only is it of importance that the State should be fully acquainted with the value of its mineral resources, but also that private individuals should be able to get any information they might require concerning mineral fields, and so every opportunity be given for the development of our mineral resources. Such information can now be obtained in England,

and also in New South Wales, as far as relates to any mine which has once been worked.

After the geology of the mineral fields has been investigated by competent geological surveyors. The surveyors of mining fields, who are attached to the Warden's staff, should, on each mining field, be able to continue the work of recording new discoveries and making new maps to suit the changing condition of each mineral field. But, to do this, they would require to have geological knowledge, which they should have as a *sine qua non*.

In conclusion, it is to be hoped that, before long, we shall have a permanent geological survey for the whole colony on a scientific basis. I have already pointed out that in almost every country in Europe, in the United States, and in most of our leading colonies, such a survey already exists. It is time that Queensland should recognize the importance of the discovery of its mineral resources, and the investigation of the geological structure of the colony, as a part of the policy of the State. We ought, in fact, to be continually taking stock of our resources. It should be part of the duty of such a survey to discover new mineral fields, and to mark out the areas which contain water-bearing rocks; in fact, to pay special attention to the hydro-geology of the country. But, if such a permanent survey is to be established, it will have to be on an independent footing, and not at the beck and call of every Minister for Mines, who may want information about some new mineral field. It seems to me that the establishment of such a geological survey, on the lines suggested, would amply repay the colony in the long run.

NOTES.

I.—Artesian Wells and Water Supply (Plate XVI.), by John Falconer, C.E.

In a paper read by me before the Society, in March, 1884, on "Springs and their Origin," I there stated that Artesian Water would be found at a depth of 200 feet, in the Maranoa District.*

Circumstances, created by the dry season, induced the Chief Engineer for Railways, Mr. H. C. Stanley, to have a well put down at Mitchell, and, from the success which attended that experiment, he instructed me to put down another at Dulbydilla. This well was also successful, water being struck on the top of the shale.

In the first well the water rose to within 10 feet of the surface, and was allowed to overflow the guide pipe at 20 feet from the surface. It was thought, at first, that the overflow would have been sufficient to meet the requirements of the Department without the necessity of pumping. This well has been tested for a depth to 8000 gallons per day. A 6-inch bore has since been put down, which has increased the quantity of water overflowing, and which may obviate the necessity of pumping from a depth.

The second bore, at Dulbydilla, was put down 370 feet, 14 feet into the upper surface of the shale bed through which the Mitchell well was bored. This well, as will be seen on reference to the above plate, was commenced at a point 340 feet above the well at Mitchell, consequently, the water, which rose 190 feet, is accumulated,in this case, on the top of the shale, thereby establishing a most important point relating to the geological formation of the Western Downs, and the depth at which permanent artesian water may be obtained by boring in the district lying between Miles and Adavale. This information may be briefly summed up as follows:

* Proceedings, Royal Society, Queensland, Vol. I., p. 29. Bris., 1884.

1. This peculiar shale, which may be called the Mitchell Shale, has been laid down originally in deep still water, and dips about six inches to the mile, south by west; it consequently appears to run nearly horizontal on the Western Railway Line.

2. As I had several years ago concluded, from observations made at the outcrops in the various creeks crossing the Western Railway Line from Miles to Angellala, this shale averages 200 feet in thickness, and is overlaid by recent coal seams and desert sandstones. The same fossil (a small pecten) is to be found in all the outcrops of this shale, hundreds of miles apart.

The Government geologist, Mr. R. L. Jack, recognised this shale as being identical with that found over a large extent of country to the north-west; so that, it is of importance to know how far the above conditions extend.

I informed the Chairman of the Murrweh Divisional Board, at Charleville, that he would get plenty of water within 50 or 60 feet of the surface of that place, acting under the assumption that the surface line of the shale was permanent. (The level of Charleville is 966 feet, and that of Mitchell 1,100 feet above sea level, and this difference being taken into consideration and allowance made for the dip, as above, the bottom of the shale would be reached at 53 feet.) The result within the last few days has been 18,000 gallons per day, at a depth of 53 feet.

All the sandstone spurs, or ranges, crossing the railway line, except one at Amby, where there has been volcanic action, are due to the erosion of the valleys, and not to elevation.

The rocks, as met with in the outcrops on the higher slopes of the range, and as procured from a depth by boring along the direction of the dip have invariably corresponded.

I think it would be difficult to select a place west of Roma, where artesian water could not be obtained.*

* The occurrence of intrusive or erupted rocks would of course afford conditions which might be unfavourable to such a result, as far as

II.—"The Palm Raphia (Sagus) ruffia," by L. A. Bernays F.L.S., etc.

The marked success which has attended the efforts of past years to introduce and establish many species of that noble order of plants, the Palms, gives peculiar interest to any new evidence of their adaptability to our climate; and, having myself taken a considerable share in the work of their introduction, I am always glad of an opportunity of pointing to successful results, with a view to encourage the cultivation of these beautiful and useful plants. Such an opportunity presents itself now, in the fruiting, for the first time, in Queensland, of a specimen of the small genus *Raphia*, viz., *R. ruffia.* The specimen in question was planted some twelve years ago, in the Acclimatisation Society's gardens, of which the tree has been one of the most admired objects. Unfortunately, this genus is one which, like the banana, dies after fruiting, but which, unlike that fruit, fails to leave behind it young and vigorous successors. If, and there is no reason to doubt from the size which it has already attained, the fruit which I am submitting to you, comes to perfect maturity, the parent plant can be replaced by a numerous progeny, indeed.

I submit examples of the fruit and fibre.

The "hands," as I may term them, now shewn, were taken from a fruit-spike, about five feet long, and are two, of one hundred and eighteen, which were arranged spirally on the spike. Of these hands 47 were fruitful, and 71 sterile. There were 16 fruit-spikes, and allowing an average of 20 seeds to each fertile hand, gives a result of about 15,000 of the beautifully imbricated

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particular districts are concerned, for the continuity of the Mitchell Shale would be thereby disturbed. A remark which has been suggested by the fact that a dyke is to be met with on the Warrego River below Wallall. This dyke, which was brought to my notice by Mr. R. Austin, railway surveyor, is supposed to extend between Mitchell and Mangalore, and to have a direction of 13 deg. south of west. Its influence may be traced on the course of the rivers of the district.

scaly fruits to the tree in question. If, therefore, the crop matures properly, the whole of our coast-line can be supplied with this beautiful and useful Palm. The species is African, but its exact natural habitat does not appear to be known. It is a cultivated plant in Madagascar and neighbouring islands, and favours low swampy land; although the specimen in question is growing under conditions quite the reverse.

This species, with the only two others known, viz., *R. toedigera* (the Jupati Palm), a native of Amazon, and *R. vinifera*, found on the Niger, have stout, unarmed, short, ringed trunks, with large and spiny leaves, sometimes fifty feet in length, and erect, the entire tree attaining a height of 60 to 70 feet. The leaves of all these species are put to many uses. The women in Madagascar use them with wonderful skill. They divide the outside skin of the leaf into fine threads; these they dry, and then weave them into a soft and very pretty fabric. The fibre is also largely manufactured into a kind of matting, used both for wrapping and for floors. Of this matting the shipments to Mauritius from Madagascar in one year, reached nearly 100,000 rolls, together with two tons of the fibre; for the fibre, the outer skin of the leaves, is used, and it is peeled off in strips while the leaves are young.

III.—On the Curative Properties of the *Cunjevoi* Colocasia macrorrhiza, *Schott*, by Hon. W. Pettigrew, M.L.C.

It is a well ascertained fact amongst residents in the Parishes of Mooloolah and Maroochi, to the north of Brisbane, that if a person is stung by contact with the leaf of the "stinging tree" (Laportea gigas, *Wedd.*), and the affected part afterwards rubbed at intervals during an hour or so, with the leaf of the Cunjevoi, the pain will cease and not return again; whereas, should no such application be made, the pain will return for a considerable time after, whenever the injured part is made wet; and a case has been mentioned to me of a man who experienced pain, under these conditions, even when a month had elapsed since the time when he was stung.

In these districts a further use also has been found for this plant. The circumstance to which allusion is made, is that of a Mrs. Trail, the mother-in-law of the Postmaster at Mooloolah, who accidentally fell over a galvanized iron tub, and so bruised her leg, without, however, abraiding the skin. The injured part became swollen, discoloured, and finally ruptured. Various remedies were applied, but no healing was effected, though carbolic oil prevented the ulcer from becoming any worse. This state of things had lasted, with much consequent suffering, for two years, when Mrs. T. was prevailed on by a friend to try Cunjevoi leaves, with the assurance that, though their application would cause much pain, they might ultimately prove beneficial, and that meanwhile no ill effect could result from their use. The leaves were prepared in the following manner:—They were first divested of their midrib and other prominent fibrous portions, which were torn off, and then held in front of the fire until they blistered and split, when they were bruised by being beaten until soft, when they were ready for immediate application. The Cunjevoi was used in this manner for five or six weeks, when the whole surface in contact with the leaves became covered with small blisters containing pus. The pain attendant on the use of the leaf was at length so great that it was only applied during the day—Holloway's ointment being used at night. In about three months from the commencement of the use of the Cunjevoi leaves, the leg showed signs of healing, and quickly got well. There has been no recurrence of the symptoms after the lapse of eleven months.

Yet another evidence of its value has come to my notice, in the case of a man residing in the Parish of Bribie, who suffered from a long continued pain in his back, and who was cured by simply applying the leaves in the form of a poultice to the sea of the affection.

The Colcasia and the Laportea both occur plentifully in the Mooloolah and Maroochi scrubs—the bane and antidote* growing together. The former—the Cunjevoi—may be at once recognised by its upwardly directed large broadly cordate pointed and succulent leaves, which often attain dimensions of 18 inches long and 13 inches wide. These leaves spring, by stalks of greater or less length, from a thick root-stock, which, though usually concealed, is often exposed by the loose soil surrounding it being washed away, retaining its position meanwhile by means of roots which penetrate deeply into the ground. The flower somewhat resembles that of an Arum, and is enclosed in a conspicuous spathe or sheath, the base of which persists and afterwards encloses the small berries which contain the seeds.

Should these remarks be suggestive of further investigation, it were perhaps well to state that the Postmaster at Mooloolah is in a position to forward the Cunjevoi in quantity to those who cannot otherwise obtain it, and are willing to defray the expenses of procuring it.

EXHIBITS.

Specimens of rocks and rock cores, by Mr. J. Falconer. The fruiting spathe and fibre derived from the palm *Raphia ruffia*, by Mr. L. A. Bernays.

The root, leaves, and fruit of *Colcasia macrorrhiza*—the "Cunjevoi," of the Mooloolah and Maroochi districts—by the Hon. W. Pettigrew, M.L.C.

A chart, showing the register for November, of a self-recording aneroid barometer, by Mr. J. Thorpe.

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* I am informed that the inner bark of the Nettle serves as an antidote to the sting from the leaves of the tree itself.

INDEX.

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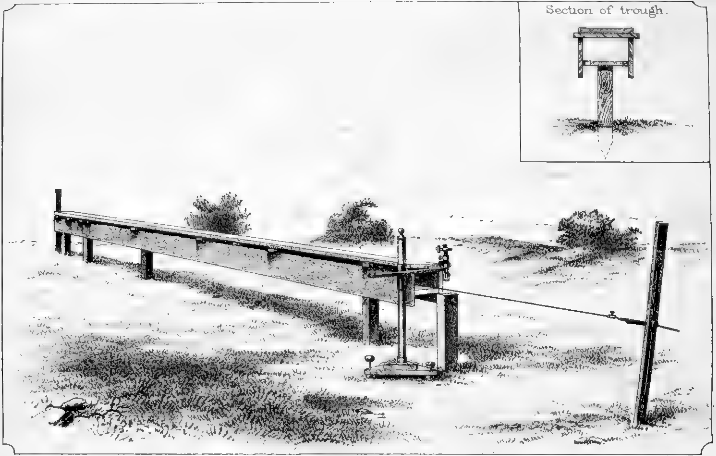
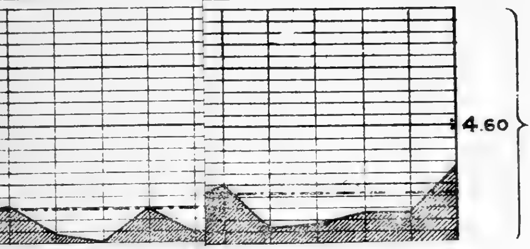
Section of trough.

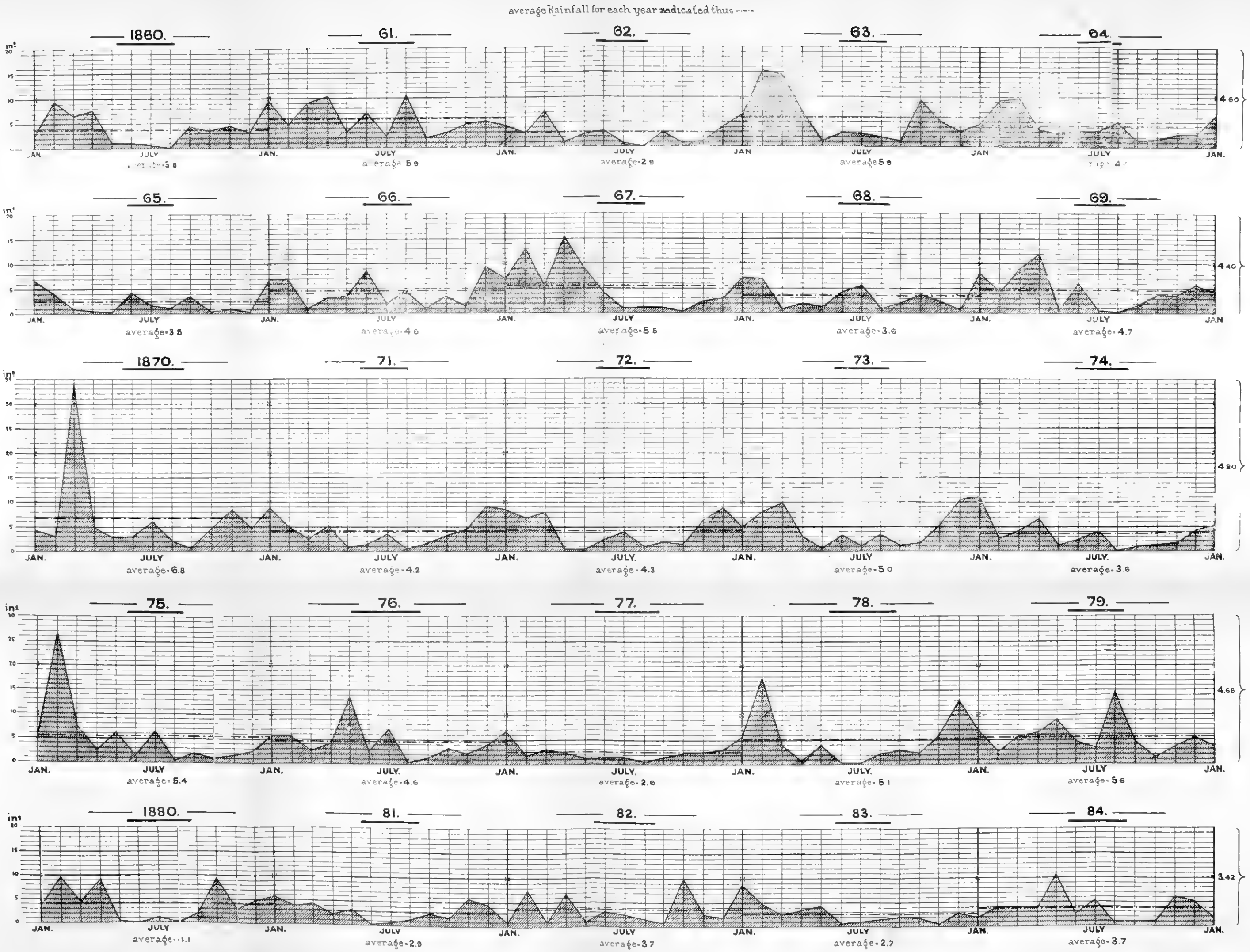


Sketch shewing trough, microscope and strainer with spring balance.

r each year indic

62.




average Rainfall for each year indicated thus
1860.
61.
62.
63.
64.
65.
66.
67.
68.
69.
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73.
74.
75.
76.
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78.
79.
1880.
81.
82.
83.
84.
JAN.
JULY
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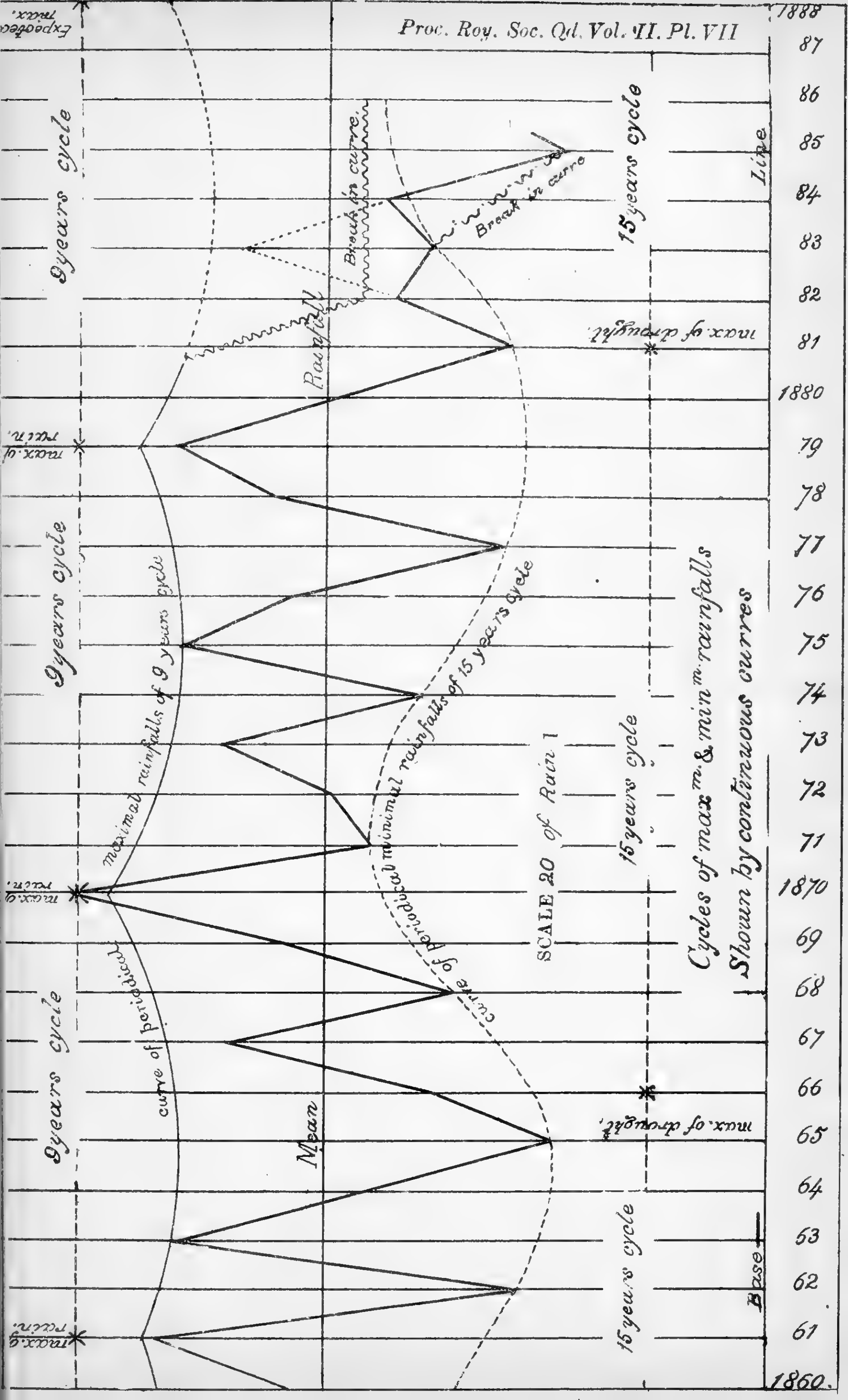
average-5.5
average-3.6
average-4.7
4.40
average-6.8
average-4.2
average-4.3
average-5.0
average-3.6
4.80
average-5.4
average-4.6
average-2.6
average-5.1
average-5.6
4.66
average-2.9
average-3.7
average-2.7
average-3.7
3.42


Expected max.
9 years cycle
9 years cycle
9 years cycle
max. of rain.
max. of rain.
max. of rain.
Rainfall
Break in curve.
Break in curve
Mean
curve of periodical maximal rainfalls of 9 years cycle
curve of periodical minimal rainfalls of 15 years cycle
SCALE 20 of Rain 1
15 years cycle
15 years cycle
15 years cycle
15 years cycle
max. of drought.
max. of drought.
Cycles of max^{m}. & min^{m}. rainfalls
Shown by continuous curves
Line
Base
1888
87
86
85
84
83
82
81
1880
79
78
77
76
75
74
73
72
71
1870
69
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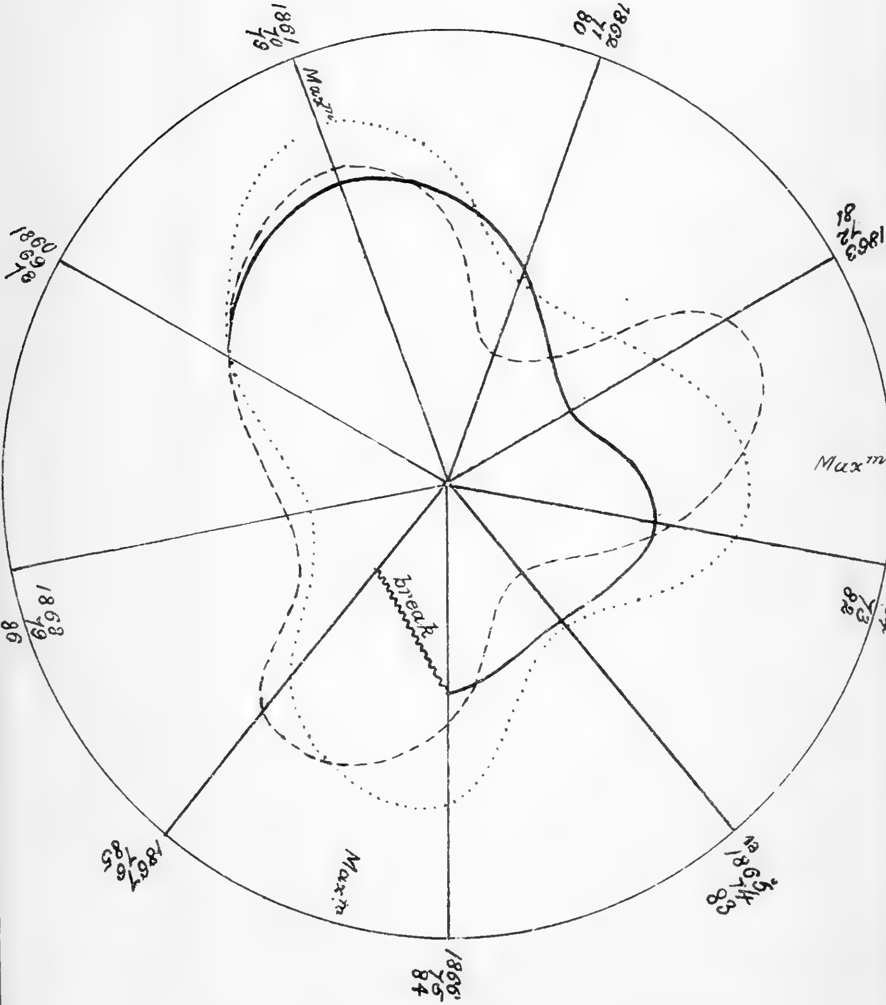
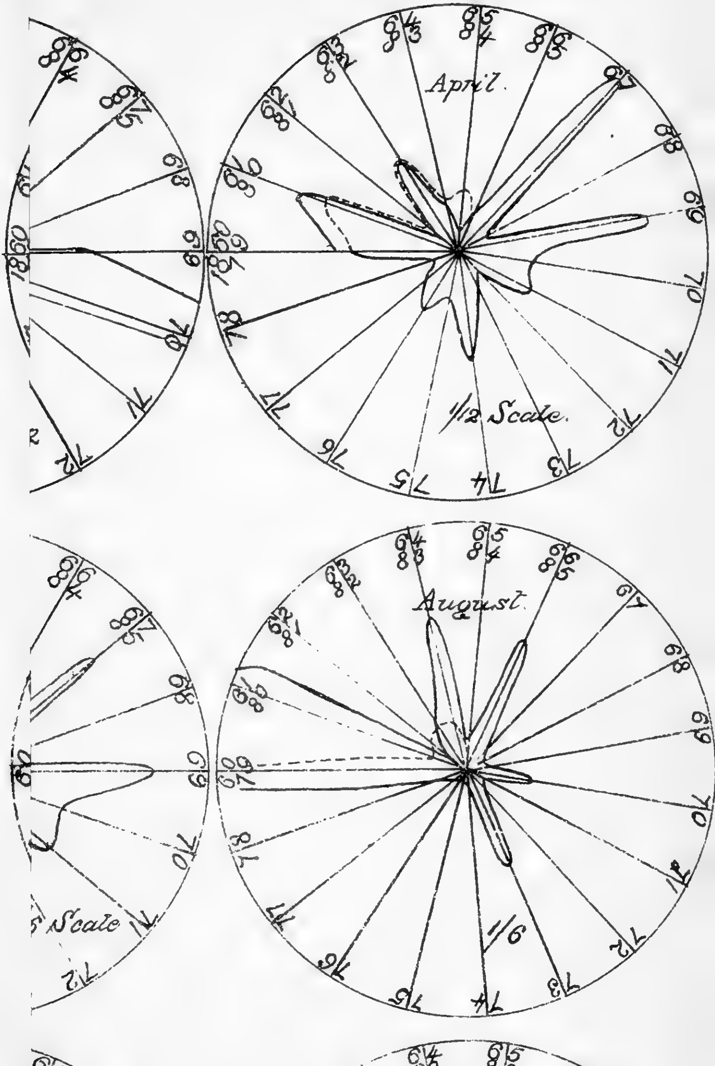
67
66
65
64
63
62
61
1860.

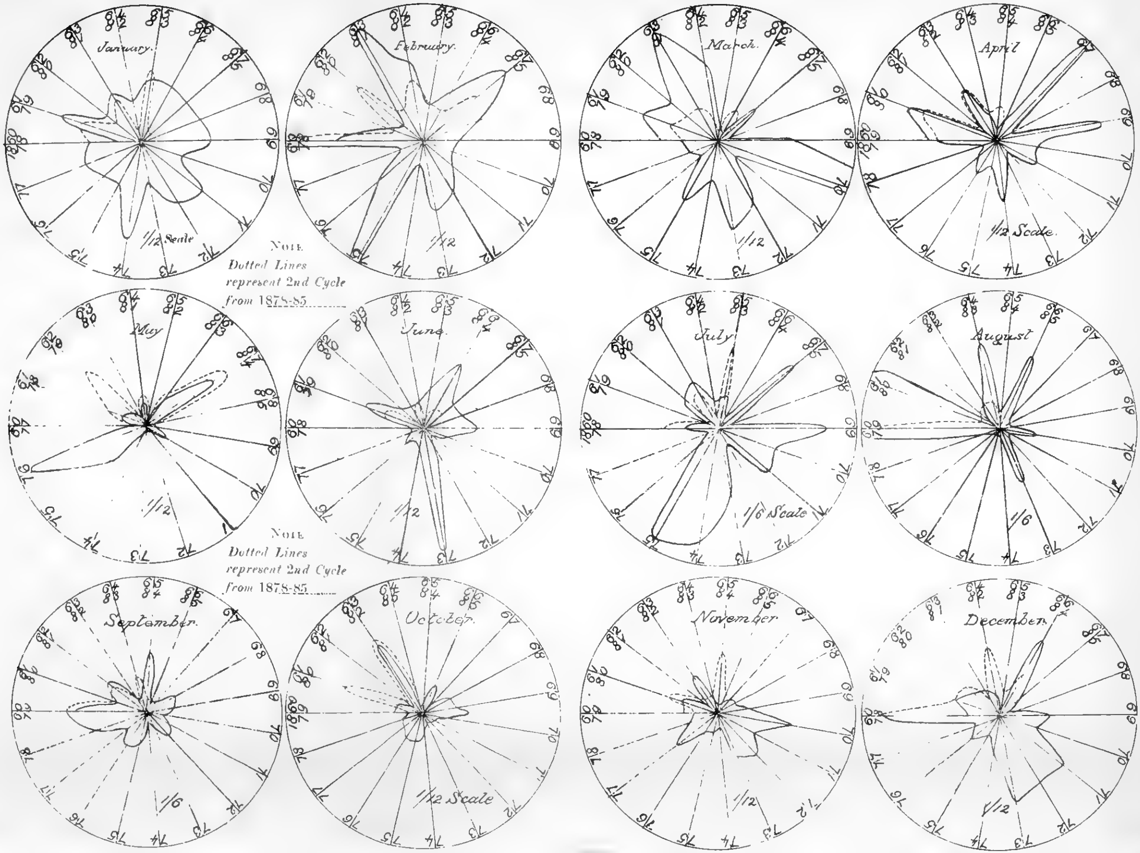
Rainfall from 1860 to 1885, represented by curves of 9 years cycle.



First Cycle 1860–9 - - - - - - - *Second Cycle 1869–78* . . . .

Third Cycle 1878 — 85 ~~~~~~


April.
1/2 Scale.
August.
1/6
Scale
December.


January.
1/12 Scale
February.
1/12
March.
1/12
April
1/2 Scale.
Note
Dotted Lines represent 2nd Cycle from 1878-85
May
1/12
June.
1/12
July
1/6 Scale
August
1/6
Note
Dotted Lines represent 2nd Cycle from 1878-85
September.
1/6
October.
1/12 Scale
November
1/12
December.
1/12

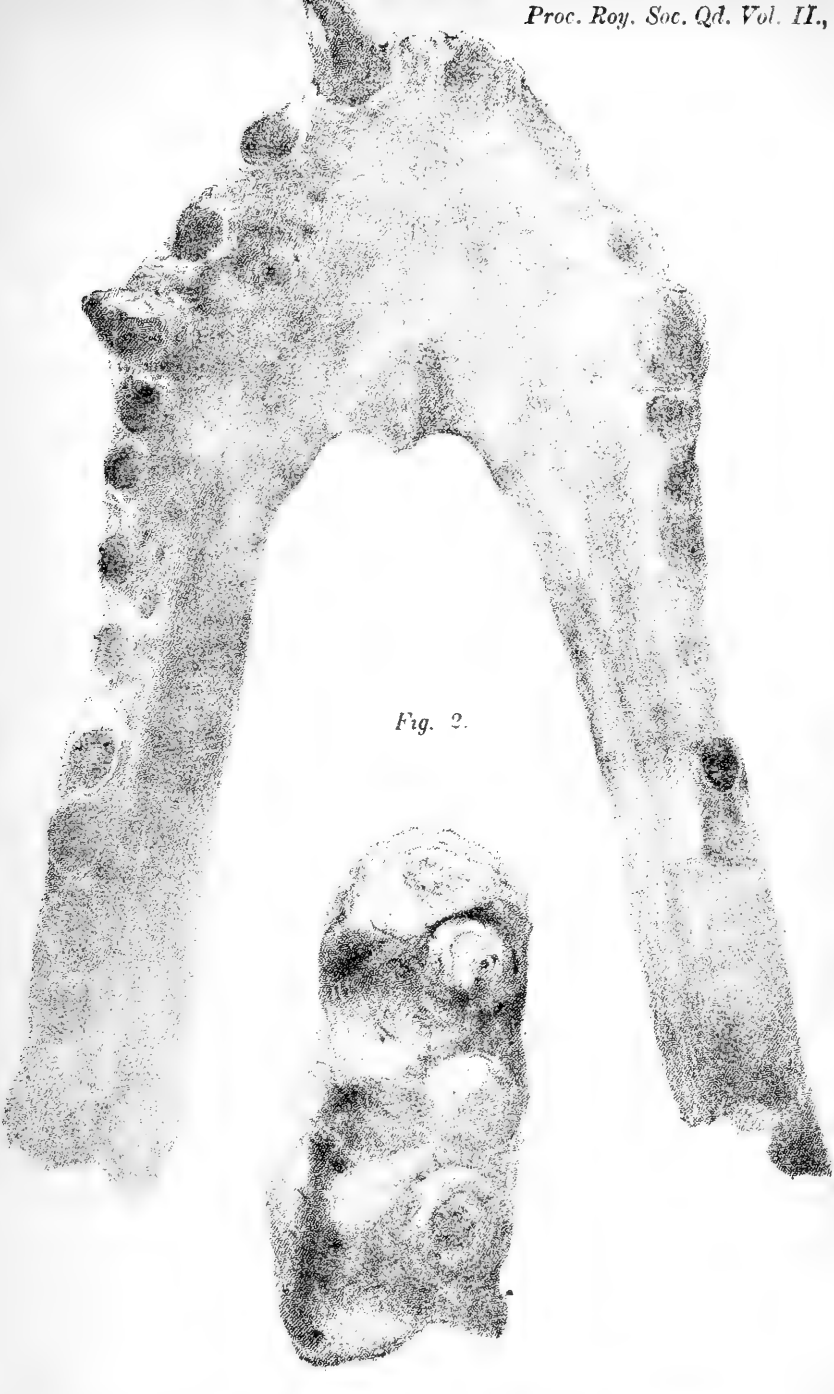


Fig. 1. ANTERIOR HALF LOWER JAW (YOUNG).

Fig. 2. PORTION OF HINDER PART OF MAXILLARY.

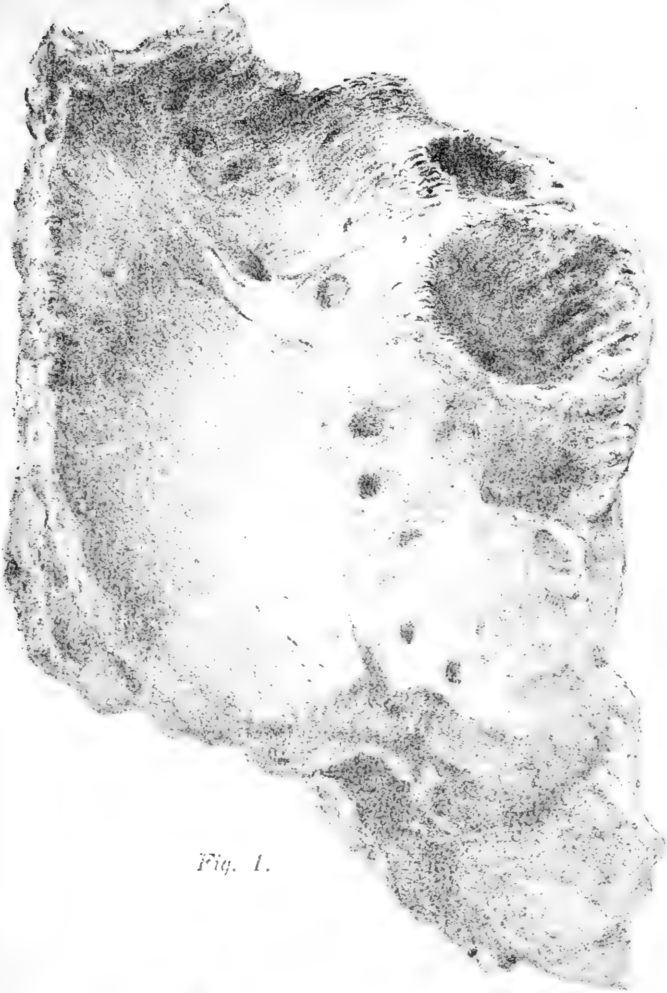


Fig. 1.

Fig. 2.

Fig. 1. RIGHT MANDIBLE. *Fig. 2.* CONDYLE

Nat. Size.

RIGHT MANDIBLE.

Nat. Size.

PREMAXILLARY.

Fig. 1.

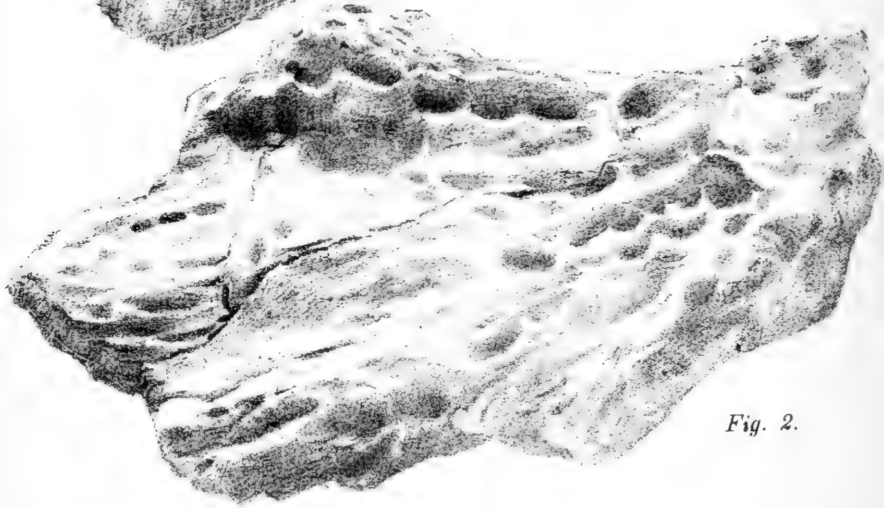
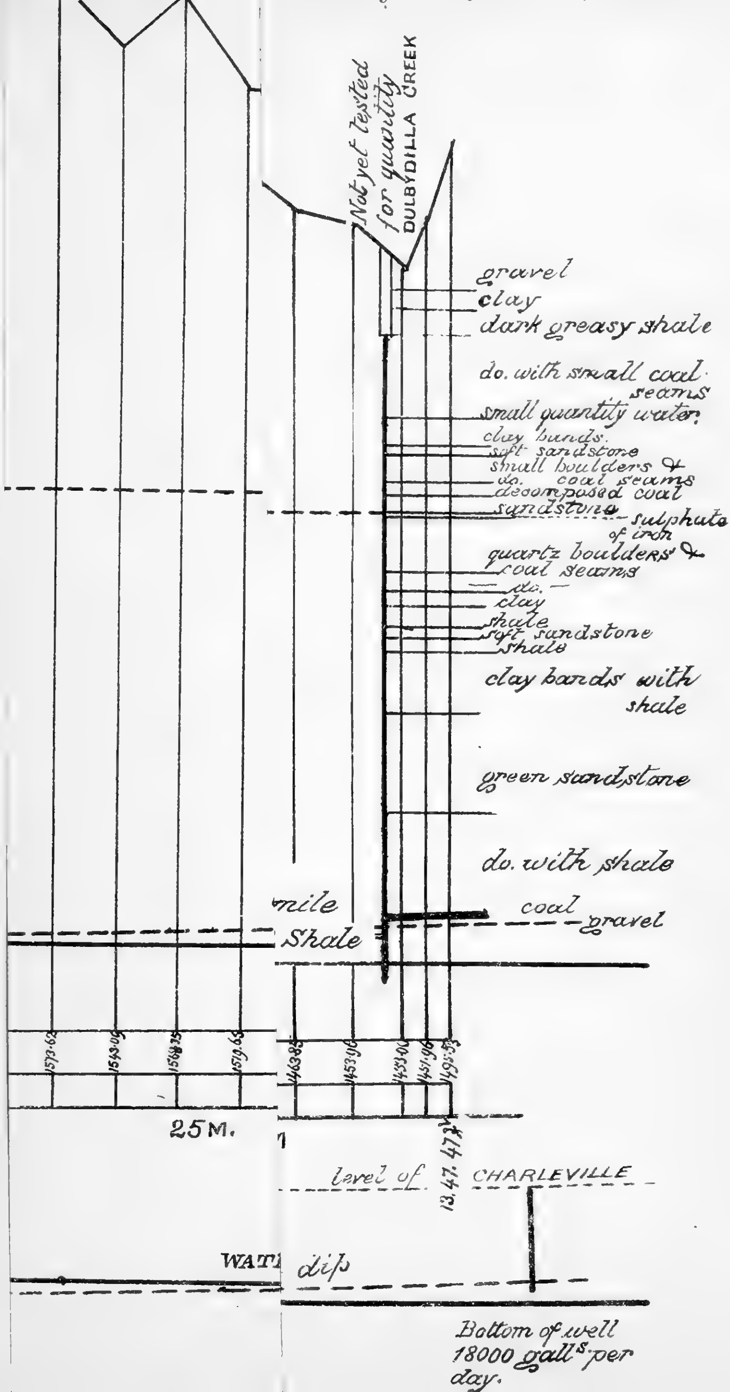


Fig. 2.

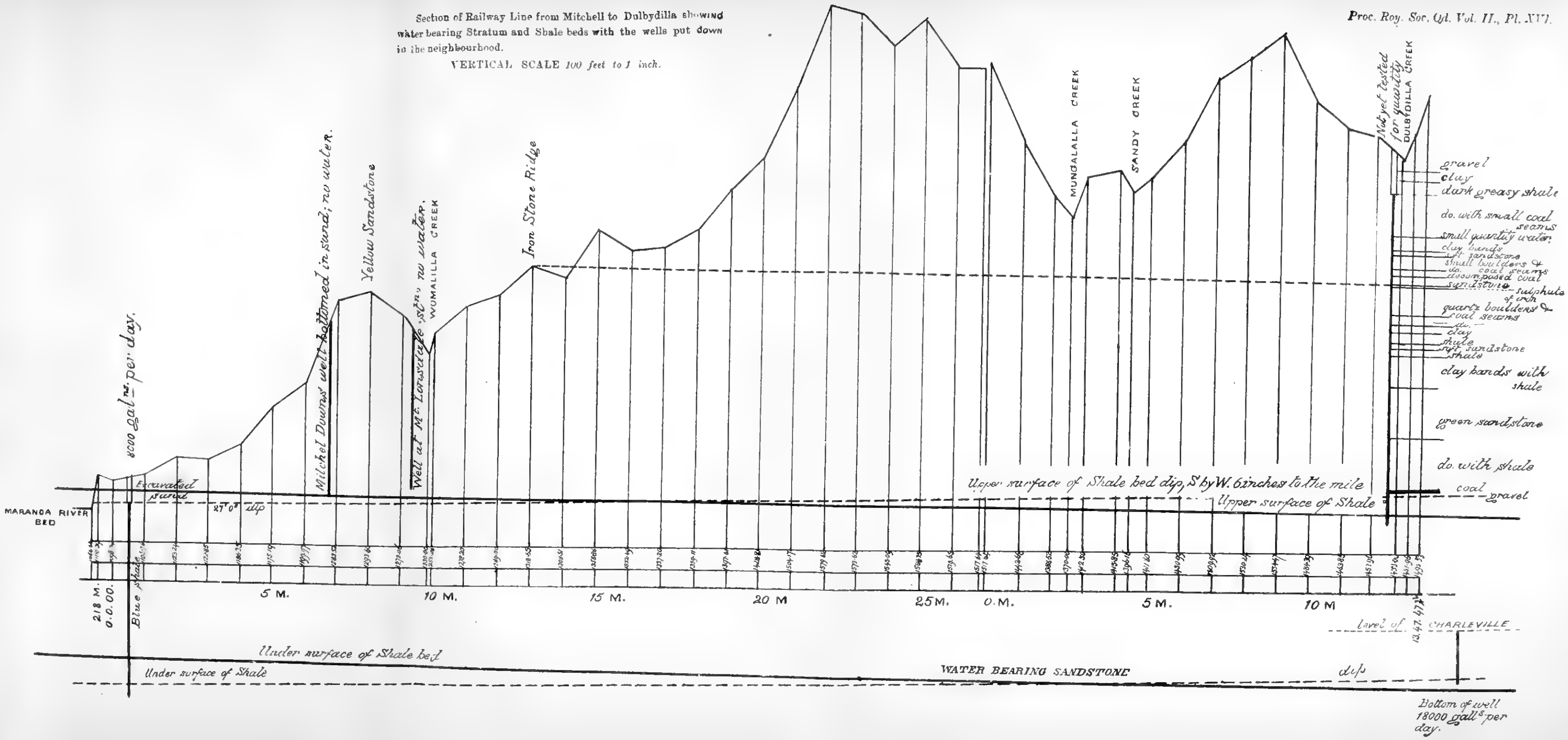
Fig. 1. LEFT MALAR *Fig. 2.* PREFRONTAL

SCUTES.


Not yet tested for quantity
DULBYDILLA CREEK
gravel
clay
dark greasy shale
do. with small coal seams
small quantity water.
clay bands.
soft sandstone
small boulders &
do. coal seams
decomposed coal
sandstone
sulphate of iron
quartz boulders &
coal seams
do.
clay
shale
soft sandstone
shale
clay bands with shale
green sandstone
do. with shale
mile
coal
gravel
Shale
1573.62
1543.09
1564.35
1519.63
1463.85
1453.96
1453.90
1451.96
1495.53
25 M.
13.47. 47¾
level of
CHARLEVILLE
WAT
dip
Bottom of well
18000 gall^s per day.

Section of Railway Line from Mitchell to Dulbydilla showing water bearing Stratum and Shale beds with the wells put down in the neighbourhood.

VERTICAL SCALE 100 feet to 1 inch.



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CONTENTS.

PAPERS—

NOTES—

PLATES.

Royal Society of Queensland.

FRIDAY, JANUARY 8TH, 1886.

THE PRESIDENT, L. A. BERNAYS, ESQ., F.L.S., ETC., IN THE CHAIR.

THE Hon. Secretary announced the measures which had been adopted to bring the "Forbes' Expedition Aid Fund" before the public, and stated that £59 12s. had already been subscribed by 29 members and others. He also mentioned that the Council had decided to close the subscription list on the 28th February.

NEW MEMBERS.

Mr. G. F. Scott, Brisbane; Dr. W. Grant Furley, Brisbane; Mr. A. J. Boyd, Nundah.

DONATIONS.

"Report of the Board of Governors of the Public Library, Museum and Art Gallery of South Australia, 1884-5." Adelaide, 1885. From the Director, Adelaide.

"Abstract of Proceedings," Nov. 16, Hobart, 1885. From the Royal Society of Tasmania.

"Victorian Naturalist," Vol. II., No. 8. Melbourne, Dec., 1885. From the Field Naturalists' Club of Victoria.

"Proceedings of the Academy of Natural Sciences," Part II. April to July, 1885. Philadelphia. From the Academy.

"Proceedings of the Linnean Society of New South Wales," Vol. X., part 3. Sydney, 1885. From the Society.

"The Australian Irrigationist," No. 17. Melbourne, 1885. From the Editor.

"Journal of the Asiatic Society of Bengal," Vol. LIII., part II., Nos. 1, 2 and 3, 1884; and Vol. LIV., part II., Nos. 1 and 2, 1885. From the Society.

Drawings of South American Palms, from Mr. L. A. Bernays.

The following Papers were read:—

NOTES ON A TRIP TO NEW GUINEA;

BY

J. W. POTTS, Esq.

(Read on 8th January, 1886.)

THE interest at this time associated with any statements relating to New Guinea makes it not improbable that the following brief account of a short visit to that country, from which indeed I have only lately returned, will be acceptable to the members of the Society.

Having been long occupied in compiling a map of New Guinea, which should embody all the authentic information obtainable from the British, Dutch, and French Admiralties, and from the works of explorers and missionaries generally on the subject, I had for a considerable time contemplated such a trip as described. Accordingly, on the 10th September, 1885, I left Brisbane, in the steamer Elamang, for Thursday Island, with the intention, on arrival there, of embracing the first opportunity of reaching the New Guinea coast. Having gained then this starting point I took an early opportunity of calling on the Hon. John Douglas, C.M.G., who afforded me such information as might be of immediate service to me. From Thursday Island I crossed over to Prince of Wales Island, a large island some ten or twelve miles square, lying immediately to the south-west. Here I camped for a week, examining the island by travelling across and around it. I found the coast to be generally rugged, though containing several small sandy bays. The country itself appeared to be of volcanic origin, and very barren—a considerable part being composed of rock and loose stones, with intervening salt-marsh flats. At a distance of some miles from the coast, and 298 feet above the sea-level, I observed an extinct crater. Its depth, as ascertained by a plumb line, exceeded 100 feet, whilst it had a diameter of fully 25 feet. Forming as it did a natural reservoir, it was full of fresh-water, and in this I noticed numerous molluscs, probably referrable to the genus *Melania*. Strange to say, the residents of Thursday Island were previously unaware of the existence of this crater, but since my visit the place has been officially visited with a view to ascertain how far it is practicable to conduct the water from this source to the coast. It is in the above-mentioned sandy bays that the pearl-fishers of Torres Straits have built their fishing stations, availing themselves of the protection from the north-west monsoons which Prince of Wales Island affords. The island is stated to abound in wild pigs and birds, and I occupied some time in pursuit of these. Whilst at this camp, the commander of the Australian Squadron, Admiral Tryon, visited the island, and seemed to be impressed with the suitability of some such island in Torres Straits for the purposes of a naval coaling station and commissariat.

On returning to Thursday Island I experienced some difficulty in chartering a vessel suitable for my future journeyings. A new patch of pearl-shell, which had been recently discovered in Steam Boat Channel, had presented unusual attractions. All trade for Port Moresby was at this time obtained from Cooktown, whence accordingly vessels embarked for that destination. I was, however, enabled to obtain the services of the "Elsea," a schooner of 70 tons, which had until recently been engaged in the Port Moresby trade from Thursday Island. Having then chartered this vessel for two months, with the option of a renewal for a further term of one month, I set sail from Thursday Island on 1st October, in company with Captain Dubbins and Mr. Jack Longley, and a crew of ten South Sea Islanders. A strong but favourable south-east wind brought the schooner to Double Island, at which place we anchored for the first night. Another day's sailing brought us to Sand Bank—between Long Island and Park Island—but we did not go ashore there. On the 4th October the "Elsea" reached Village Island. Here I found the remains of an old native settlement, but all the inhabitants of the island had disappeared. Some of them had gone as recruits in the "labour trade" and never returned, others had fallen as victims of the white-men's vices, and the remnant had removed to some other island. Here it was that I met with the white, or Torres Straits, pigeon *(Carpophaga spilorrhoa*, Gray), which is at times observed in these latitudes flying in such immense flocks from island to island. We next visited Dalrymple Island, the residence of Mr. Walker and "Yankee Ned," who are engaged in fishing, and employ the natives of the place to help them in their pursuits. The wrecks of the "John de Cosa" and "Fenstantin" are conspicuous objects at Dalrymple Island, both fine ships being high and dry on the reefs. On the 6th October we passed Bramble Bay, and then sailed through the Gulf of Papua, making the mainland at Cape Possession on the 8th, and thence keeping along the Coast of New Guinea we arrived at Port Moresby on the 11th, and were soon boarded by Mr. Lawes, jun., the local custom-house and shipping officer, who delivered a printed budget of rules, regulations and cautions issued by the authorities. Port Moresby is certainly a fine harbour, but the land in the immediate neighbourhood of the shore is poor, and so abrupt and near are the surrounding limestone hills that there are no rivers or creeks running into it. Its northern division, however, known as Fairfax Harbour, is of somewhat different character. The shores of this portion are the site of five native villages, the inhabitants of which largely subsist by fishing. On the north side of Fairfax Harbour there is a plateau of land better adapted for the purposes of an English town or city than is that at present selected for the proposed capital. On the evening of the day of my arrival at Port Moresby I went ashore and visited Mrs. Lawes, so widely known for her hospitality to visitors to those shores. I also called officially on the Deputy Commissioner, Mr. Anthony Musgrave, jun., to whom I presented my passport and letters of introduction. Whilst walking through this missionary village, known as Anua-pata, I was much interested in observing the old women busily occupied in pounding clay in wooden troughs, and after pulverising it sufficiently, moulding it by means only of a flat stick and the hands into the form of spherical vessels with circular lips. These utensils, some of which are of considerable size, are largely manufactured here, and serve as articles of trade with neighbouring Papuans, and especially with the coastal tribes of the Papuan Gulf, such as the Maiva, from whom sago is received in exchange. I was informed that only a week or two prior to my visit some five hundred men left in canoes laden with pottery of this description, and were expected to return with sago and other goods as soon as ever the west monsoons had set in.

The chief implements for war purposes in use amongst the Motu people—for so the natives of Port Moresby are designated—are a stone club, a stick terminated by a perforated disc of stone whose border is sometimes perfect, at other times carved into and so, in lieu of being discoid, becoming star-like; a palm-wood spear and a shield. In reference, however, to stone weapons, it is very evident that these are fast giving place to those made of iron, and the stone-age in Port Moresby district will very shortly be a thing of the past.

It appeared that the Motu people had already grown alarmed at what they regarded as the encroachment of the whites, and looked with a jealous eye at all resumption of their land, as well as at the erection of buildings upon it. It was accordingly decided by the authorities that it was advisable to purchase from the Koitapu (a neighbouring tribe but one residing away from the coast) a piece of land with which to effect an exchange with the Motu natives for land close to the town. And it was for this purpose that the Deputy Commissioner invited me to accompany him to the Koitapu village, whither his interpreter, Ruotoka, had set out on foot some hours earlier. After riding over the high limestone coast range the prospect assumed an agreeable change. The country was now undulating and reminded one of the Allora district of the Darling Downs of Queensland. The soil had changed to a somewhat rich loam and was studded here and there with copses of indigenous fruit trees, sago palms, and mangoes in full bearing, interspersed with small rock-bound lagoons encircled by luxuriant ferns. Away to the west was forest country, and here grew different species of Eucalyptus, one of which closely resembled the Moreton Bay Ash (*E. tesselaris*). The village itself was surrounded by native gardens in which flourished yams, taro, and bananas. On our arrival there, during the afternoon, we found that the chief of the village was already out with the interpreter and with his own followers engaged in going over the intended purchase. We lost no time, however, in discovering his whereabouts, and, having gained his good graces by the usual present of tobacco, etc., immediately proceeded to business.

The native tenure of land in this district appears to be peculiar. The land is held in blocks by each family, and every member is free to cultivate any uncultivated portion thereof, and the crops he raises are his own property. On his death, his children, both sons and daughters, are allowed also to cultivate any portion of the original block not already utilised for this purpose. No member of a family can sell his right to cultivate to any other member in the tribe without the consent of the whole family; and no family is allowed to sell its land, without the consent of the tribe. A purchase therefore, under such circumstances, is no small matter. The negotiations, however, were on this occasion brought to a successful issue, but only after much talk and a distinct promise that "Britannia's men should not settle on the land."

Subsequent observation led me to the conclusion that the Koitapu, like the Motu people, were generally shorter in stature than the Gulf of Papua tribes; also that their tattoo marks had an entirely different character. In fact, I noticed that every tribe had distinctive tattoo marks of its own, as was also the case with the scrolls and arabesques with which their implements, weapons and even their pipes, or 'bau-bau,' were ornamented; and that different tribes could be identified by having regard to this amongst other considerations. Returning to Port Moresby, on the same evening after this land transaction had been accomplished, I slept on board the schooner; and on the morrow I started on an inland trip, Mr. Lawes having kindly placed horses at my disposal. Accompanied by Anua-pata men as bearers, we proceeded first along the native tracks which traversed the plantations, and then over the range by a direct route until we struck the bed of a dry creek, which, on being followed upwards, led into an extensive swamp.

Passing through this swampy country for some miles, we crossed another small range, which was succeeded by richly grassed country resembling our Apple-tree Flats. All this country was well watered and intersected by rivers which ran into a lake where water-fowl abounded and where also the natives reported alligators. Some native women from a neighbouring settlement were gathering, as we passed, the roots of some water-lily growing in the lake, for the purpose, as I surmise, of preparing a food substance from them; but on our approach they made off in all haste to the scrub. Swamps such as we had been traversing are the very hot-bed of a fever, which in New Guinea appears to attack both native and white with equal malignity. I accordingly selected rising ground near the lake for a camping ground, but, notwithstanding, found the weather very oppressive, the temperature ranging from 90° to 100° Fahr. all the night through. Having "boiled the billy" and picketed our horses, night set in, and by way of amusement the bearers held a "couf-buy," or native dance, in front of the large camp-fires, keeping up a steady time to the beating of billy-cans, spoons, can-lids, etc.—our substitute for a band. The reflection of the light from the fires on the dancers, decorated as they were with green boughs, and the due prominence given to their stout and well-proportioned bodies and white teeth by contrast with the background of rich dark scrub, afforded a wild and effective scene. After a while there was a general request that "Britannia" also should dance, and to this demand I readily acceded by giving them what few steps I knew of the Highland fling, and which were received with roars of laughter. These steps I then taught to one of the boys, and, after a short rehearsal, the whole of his comrades picked them up from his tuition, and engaged in the dance like true Scotchmen, only to their own music. Early next morning we were on the move, travelling mainly north, and keeping along the bank of the Laloki River. This river takes its rise in the Owen-Stanley Range, and, gazing across its rich scrub-belted stream, we beheld in the early morning these mountains in their full glory, their several peaks standing out in different shades of blue, one behind the other, in great clearness, and attesting the extensive nature of the mountain country of which they formed a part. The Laloki river, with its tributaries, amongst which is the Goldie, drains a very large tract of country, and ultimately empties itself into Redscar Bay. It serves as a landmark between the territories of the Koitapu tribe and those of the Koiari. These latter people own then the country on the north-east side of the Laloki River; they are essentially a mountain tribe, and, as distinguished from those of the coast districts, are short and thick-set. On the occasion of my visit they were not friendly, but, no doubt, could easily be made so by payment for the privilege of going through their country. I afterwards learnt that Mr. Goldie, of Port Moresby, leased, some five years ago, from the various tribes interested, and for a period of twenty-one years, a large tract of country through the centre of which the Laloki River flows, and having seen the lease, I found that it was evidently properly drawn, signed, and executed. I also noticed that it contained an important proviso in favour of the lessors by which the right to hunt over this country was reserved to them.

I returned to Port Moresby and left again on the morning following my arrival, in the "Elsea," having undertaken to forward dispatches on behalf of the Deputy Commissioner to the late Sir Peter Scratchley, who was then at the East end of the island. We had to beat dead to windward until we made Hula, which we entered on the morning after our departure. At Hula we remained all day, and having cleaned the schooner, left next day for Kerepuna, anchoring at the head of Hud's Lagoon. From this spot I visited Kalo and the Kalo River in a native canoe, the details of which journey I will pass over. On my return we sailed once more for the east end of New Guinea, and, after beating dead to windward during three days, met the s.s. "Governor Blackall" at sea, out of sight of land, when the despatches were delivered. Sir Peter Scratchley informed me that he had just visited Aroma, where he had hoisted the British flag. Parting company with the "Governor Blackall," we once more returned to Kerepuna. The country intervening between Kerepuna and Hula is flat and well watered. The soil is rich and black, and supports large forests of cocoanuts, wattle, and palms. Orchids abound there, and during several short excursions inland I met with many varieties. The Kerepuna reef is a grand hunting ground for a naturalist, and, during my stay in the district, I procured several interesting specimens from a "bêche-de-mer man," Mr. Dan Rowan, who was fishing there. The Kerepuna natives use the cane lasso, or man-catcher, and also stone adzes. Seeking for implements of agriculture, I found the women using a kind of wooden spade, which is, perhaps, all that is required for the soft and easily-worked ground. I was interested whilst here, in observing one of the many instances of conservation of fruit-yielding trees. The forest of cocoanuts on the west part of the Knaipa country had a taboo placed over it to allow the trees to mature, which was observed by all parties. We sailed for Port Moresby again on the sixth day, and found there H.M.S. "Diamond," H.M.S. "Lark," and the "Governor Blackall." Leaving Port Moresby we then sailed for Bola and anchored inside Lilley Island. Having gone ashore and inspected the country there, we rowed in a whale boat to Borna village, stopping the night at the house of Deri, the South Sea Island teacher.

Returning once more to the schooner we passed inside the reef, and after two days made Delera, in Hall Sound, where I also examined the country and bought objects of natural history and native workmanship. Hall Sound is a splendid harbour and is protected by Hale Island. The soil in the vicinity is like that of St. Helena, Moreton Bay, and is luxuriant with grass and other vegetation, and well supplied with springs, the water of which deposits a blue sediment. Leaving Delera we next sailed for Maiva, a thickly populated district conspicuous for its highly cultivated gardens and cocoanut forests. The villages here are kept beautifully swept and clean, and crotons and palms are planted in groves and in rows on either side of the broad streets. Each village has a large meeting house set aside for general purposes, and was used, whenever I visited a settlement, for the purpose of trading. The houses were of superior quality and built dog-kennel fashion. Amongst many noteworthy objects, I observed here the use of mosquito curtains made of fibre. The women carried their children in netted bags similar to those used amongst us for containing onions.

At the age of ten years these children are tightly belted with broad, often beautifully ornamented, thin wooden bands, which encircle the wearers more than once. It is noteworthy that here the use of the bow and the arrow appears to have superseded that of the spear and the shield. The natives at Maiva seemed to be exceedingly fond of feather ornaments and head plumes, especially when derived from birds of paradise. In fact it would appear that each chief, or "wonga," kept a number of parrots in confinement so as to have a good supply of feathers wherewith to deck himself in time of war. Looking-glasses were a favourite article of trade with these natives, and for them they would part with their tame cockatoos and parrots, which they possessed in great variety. From Maiva the "Elsea" proceeded to Moti-motu, situated on a piece of land at the mouth of the Williams River. This is a fine deep fresh-water stream, and apparently as yet unexplored. Of the rivers which are eligible to an exploring party seeking to cross New Guinea, the Williams River seems to especially recommend itself. By the Williams the north coast could be reached in sixty miles, and report states that this sixty miles is traversed by a navigable river arising on the other side of the great watershed. From the Moti-motu stream we once more proceeded to Thursday Island, which we reached after an absence of six weeks.

[In illustration of his remarks Mr. Potts exhibited, from time to time, objects of native manufacture and of natural history derived from the different localities he had visited. These are now in the Queensland Museum.—H.T.]

NOTICE OF A PROBABLE NEW SPECIES OF DENDROLAGUS;

BY

C. W. De VIS, M.A.

(Read on 8th January, 1886.)

THE relics before you, scanty as they are, seem to indicate the existence in Queensland of a species of Dendrolagus not identical with that which a short time ago was found by Dr. Lumholtz in the mountain scrubs of the Herbert River, and described by Mr. R. Collett under the name, *D. lumholtzi.* The animal now claiming attention was obtained alive by Mr. Smith, a resident on the Daintree River, from whom the skin was received, through the instrumentality of Mr. J. Pink, Curator of the Botanical Gardens. Unfortunately we have almost nothing more than the skin in question, and that by no means perfect, to mould our judgment upon, and though there are several characters pertaining to it which appear sufficient in themselves to distinguish it from that of any known member of the genus, it would hardly be satisfactory to diagnose a species from it alone. Till further materials are in hand, we must be content to invite attention to it in the general terms of description.

The hair is of one kind, that is, without intermixture of wool. On the back moderately long, glossy, rather soft, and in colour blackish-brown, especially towards the median line which, however, is not marked by a dorsal stripe; individual hairs are here deep brown at the base, broadly ringed with yellow at and below the middle, and nearly black on the distal half. On the mantle the tint becomes suffused with yellowish-red from the gradual loss of the black tips, and this passes into nearly brick-red on the nape and throat, yellowish on the shoulders and fore-limbs, and duskier red on the top of the head. The haunches, thighs, and hinder part of the belly are smoky grey, washed with a pale yellow tipping each hair. The middle of the belly is dark rufous-brown, the rump light brown, which colour descends over the base of the tail and spreads around the vent. The upper surface of the base of the tail is deep brown in a patch, which tint also descends obliquely to the lower surface where it bècomes black and continues so along that surface to the tip. The deep brown patch on the upper part of the base fades into light rufous-brown, which extends on the upper surface to its distal third, where it passes into black. The hands and feet are black, the face reddish-grey, becoming silky fawn on the frontal region, the ears deep brown externally, yellowish-brown within. The tail, which is somewhat imperfect, is still considerably longer than the head and body together; it is clothed with coarse recumbent hairs which gradually lengthen distally and appear to form a tuft at the tip. The hair of the back radiates from a point well behind the shoulders; that of the neck, proceeding forward, is continued over the head to the forehead, where it meets the backwardly directed hair of the facial region and with it forms a transverse ridge directed downwards and forwards behind the eyes towards the under surface of the head.

From these details the following brief characters may be derived:—Tail much longer than head and trunk together, hair of the neck and that of the head meeting in a ridge across the frontal region; on the back dark brown, mantle and fore limbs rufous-brown, passing into red on the neck; tail, parti-coloured.

I have no skin of Mr. Collett's *D. lumholtzi* to compare with this, but, judging from the figure and description of that species in the "Proceedings of the Zoological Society of London, 1884," p 387, I cannot but think it quite unlike the one under notice, more especially as it would appear from a remark of Mr. Collett that the colouring of his species is pretty constant. Its black head, whitish throat, and the comparatively uniform colouring of its short tail are the leading points in which *D. lumholtzi* appears to differ from its more northern congener. The rather brief description of it given unfortunately does not mention the disposition of the hair. This Daintree River animal resembles *D. brunii* in the length of its tail, and Mr. Ramsay's *dorianus* in having that organ distinctly parti-coloured, but it may be observed that in *brunii* the hair ridge is behind the head, in the other New Guinea species between the ears, and these differences are accompanied by others which are on the whole sufficiently distinctive.

We have as yet very scanty information about the habits and range of these curious marsupials. It is to be hoped that both will be ascertained before the extermination of animals so defenceless and unadaptive is brought about, as it will be at no distant day, by the destruction of our coast scrubs; for it seems probable that from the knowledge to be acquired respecting them, not a little may be inferred respecting the conditions of marsupial life in the old diprotodont days of rain and exuberant vegetation.

Were I warranted in proposing a name for this supposed species, I would at once yield to a desire to dignify it by association with that of one of our oldest and most respected Australian naturalists, Dr. G. Bennett, who has so often insisted on the probability of Dendrolagus being indigenous to Queensland. Should it prove that the skin before us really represents a distinct species, I trust that the name *D. Bennettianus* will be the one conferred upon it.

To those who take an interest in the great question of evolution, the case before us, that of the tree-kangaroo (so-called), is one worth consideration. We have here a non-saltatory modification, both in habit and structure, of the saltatory family of the marsupials. From the evolution point of view we may ask whence was it derived? From the non-evolution standpoint more directly, what are its nearest relatives? Were we to suffer ourselves to be guided by general similarity and a certain resemblance in seating and balancing faculties, we should trace the tree-kangaroo to the rock wallaby, since, superficially considered, the passage from the one into the other may appear of easy accomplishment by insensible degrees. But it happens that it is almost certain that Dendrolagus is not a modified Petrogale, but stands in the relation of either ancestor or descendant of the kangaroo-rats, the proof being that it has the peculiar dentition of that section of the Macropidæ, namely, the enormous trenchant premolar and the rudimentary canine. Had it been known by its jaws only, it would have been impossible to predicate from them its arboreal habits and adaptations, so widely different to those of the burrowing and nest-making kangaroo-rats. At present we are unable to point to any intermediate stepping stone from one to another serving to show how the passage was accomplished, but on the other hand there is no inherent improbability in the kangaroo-rats of a dense scrub country taking to the trees upon which alone they could in such circumstances find subsistence. It is far more difficult to explain on the opposite hypothesis why the tree-kangaroo should have been created with the teeth of the kangaroo rats of the plains, rather than with those of the native bear or opossum of the trees, or with an entirely different type of dentition. The explanation offered by the doctrine of natural selection is easy and rational. Those parts of the structure which required modification for a different mode of life—namely, the limbs—were so modified : those that were not so modified—the teeth—remained unchanged, because no great change in them was necessary.

The discovery of these peculiar wallabies, if we may so call them, in Queensland strengthens the opinion formed on other grounds as to the direction of dispersion of the Australasian marsupials generally, viz., that it was from South to North. Australia proper is even now their head-quarters, but it is that of a seven times decimated army. The remains of the kangaroo tribe buried in the Darling Downs drift represent probably more species in that single river valley than are now living in all the continent. It is, however, curious that Dendrolagus has not been found among them as yet, possibly it may be a late development adapted to the present conditions of our coast and of New Guinea. Should it, however, eventually be found fossil, as most probably it will be, it will serve to show how large a portion of the land was then covered with jungle, similar to those small strips to which the surviving forms are now limited.

ON THE DECADENCE OF AUSTRALIAN FORESTS;

BY

A. NORTON, M.L.A.

(Read on 8th January, 1886.)

THE forests of Australia are, after many years of ill-treatment, beginning to be regarded as sources of wealth, for an important fact has forced itself into notice: The supply of timber is not inexhaustible, nor, according to the rate at which the most useful kinds of trees are being felled, will they be sufficient for the demand that is likely to be made upon them during the next fifty years. Not only have unserviceable classes of trees been intentionally destroyed, but thousands of acres upon which were many of the most valuable eucalypts have been ring-barked, and scarcely a living specimen can be seen in some places. This is the deliberate work of men who persuade themselves that they are vastly improving the country. It is because this artificial mode of destroying has been so extravagantly carried out that the natural decay of indigenous forests becomes more important in its results and more interesting as a study. I have seen some thousands of acres, chiefly in the New England district of New South Wales, where a plague seems to have carried death through the forest; and although there are other districts where the same thing has occurred, I shall confine my remarks to the localities with which I am personally familiar.

In 1857 I ceased to reside in that part of the country. There had been an unusually heavy fall of snow in the beginning of September, and when I left, a fortnight afterwards, it was difficult in places to get through the heaps of branches that lay thick upon the roads, and even at that time large patches of snow were still lying in the shady places. It was not till I had wandered through many of the dry western districts of New South Wales and the warmer coast country of Central Queensland, that I was able to fully appreciate the healthier growth and the heavier foliage which exposed the ordinary forest eucalypts on New England to so much damage from heavy falls of snow. There was no necessity there to dodge the sun by shifting continually so as to intercept his rays with the bole of the tree under which one rested; the leafy branches cast a thick shadow which make such tactics unnecessary. This struck me particularly in 1865, and I mention the circumstance because even then a change for the worse had commenced. During five years' residence in the neighbourhood—from September, 1852, to September, 1857—I had frequently to cross a patch of country upon which there were a number of dead trees, the only survivors being low bushes of from three to five or six feet in height: this was on the Europambela run, and I was more than once assured by old hands in that part of the country that they had been blasted by lightning. It is perhaps unnecessary to say that amongst some hundreds of trees I never saw a mark of lightning on any of them. The next place where there was a noticeable instance of the kind was on the Bergen-op-Zoom run, near the township of Walcha. Here on several hundred acres the whole of the peppermint trees, as they are locally designated *(Eucalyptus dealbata)*, died away completely. The exact year when this took place I do not know, but it was not long after 1857. These trees occupy the flats between the ridges, and they intermix with the white gums *(Eucalyptus sp.**)* along the borders of the flats; but while the whole of the peppermints died, the white gums were only slightly, if at all, affected. There is now an undergrowth similar to the trees which died out. A few years later a large patch of trees on the western slope of a low range on the Tia run died in a similar manner. I have

* Without access, at the present time, to botanical specimens of this particular white gum, it were perhaps hazardous to particularise the species of Eucalyptus to which reference is made; and especially so since, as the Colonial Botanist, Mr. F. M. Bailey, F.L.S., informs me, many different eucalypts, all growing in New South Wales, have this designation in common, and Dr. Wools, the authority on the botany of the New England district, assigns the title of white gum to three different species, viz., E. stellulata, E. pauciflora, and E. amygdalina var radiata, all of which grow in this locality.

seen these from a distance, and was informed that they were the same kind of tree, and that the area over which this unusual decay took place was from 3,000 to 4,000 acres. These are instances where, on large patches of country, which have come under my own observation, the whole of the trees died without any reason being readily assignable for their doing so. But during the years which have elapsed since the peppermints on Bergen-op-Zoom suddenly died, the general appearance of the forest has in many places undergone considerable change. Ring-barking has been largely practised on New England as elsewhere, but over thousands of acres which have not been interfered with in this way the foliage has become comparatively scanty, and most of the living trees of any age are disfigured with dead branches, a certain sign that they have passed their prime. Besides this, there are many dead trees scattered through the bush, and four years ago, when I last had an opportunity of observing them, these were very much more frequent than a few years earlier. In this less sweeping work of decay the common white gums were those most affected, so far as I could judge.

Here then we have two striking facts: first, the sudden decay of large areas of one class of tree; next, the general lack of vitality in several kinds at a subsequent period. What concerns those who interest themselves in such matters is to try to suggest some probable explanation of these abnormal occurrences. Some writers who have dealt with similar phenomena in other localities, have attributed the sudden destruction to opossums. These animals have very largely increased owing to the disappearance of aboriginal blacks; and it is said that in some localities they completely denude large areas of trees of their leaves, and afterwards eat off all the young shoots continually until at last the trees succumb. Perhaps this is a correct theory. For my own part I need only observe that, although I have been in localities where there were great numbers of opossums, I have never seen trees, except a solitary specimen here and there, which have been so denuded, and I am certain that most of the dead trees which I have seen have not died from that cause. That some persons have persuaded themselves that opossums have been the chief actors in the work of destruction cannot be doubted, but were it not for their evident sincerity such an explanation would scarcely attract attention.

Another explanation which has sometimes been suggested is that a kind of grub attacks them, and having found its way into the sap between the wood and the bark, it continues its work of exploration so effectually that the flow of the sap is interfered with and the trees sicken and die. The tunnelling of numerous grubs may be seen under the loose bark of dead saplings when it peels off the stem; the appearance is familiar to those who have had to strip the bark from sapling rails when it begins to loosen; but the grub in this case does not commence his work until after the saplings have been cut and begin to dry.

Others have suggested that the trees have died because there has been too much rain; because there has been too little rain; or because of excessive cold in the more severe winters. These are some of the principal reasons which have been urged in the way of explanation, and it is not improbable that there is some truth in them. At least they are entitled to as much consideration as the theory of the opossums or that of the grubs.

The difficulty which immediately crops up when an attempt is made to solve the question, is the impossibility of obtaining any reliable data upon which to work. My personal observations have led me to believe that the causes of the decay of forests are partly climatic and partly artificial, or, in other words, the effect of the treatment which the country receives from the operations of the people who occupy it. But without being able to fix the time when the trees became affected, and to ascertain the character of the seasons antecedent to those marked changes, it is impossible to offer anything more reliable than a theory which may possibly help others to trace the cause at some future time. I shall claim therefore to make nothing more than a suggestion in this paper, that others may test its value, or otherwise, by their own experiences.

The district of New England is subject to sudden and severe changes of temperature, and although, on account of its elevation, the rainfall is more frequent than in the lower country, it is also subject to long periods of comparatively dry weather. As a rule there is sufficient rain to keep the ground in a state of perpetual dampness, and consequently the forest trees are accustomed to a continuous supply of moisture from the ground, and this imparts to them in a small degree the character of aquatic plants. This is just so much the case that they feel the effect of dry weather much more readily than trees which grow on drier country. Their more bountiful foliage necessitates an uninterrupted flow of sap, and when from any cause this is checked, their healthy growth becomes an actual source of weakness rather than of strength. It follows then that a long continuance of dry weather will produce a sickly condition in trees which have been accustomed to almost unlimited moisture. But these spells of dry weather are commonly succeeded by deluges of rain which, in the then condition of the trees, may be almost as detrimental as too little. Many of the more delicate plants which occupy prominent places in greenhouses may be killed by first stinting them till they are in a weakly condition and then flooding them with water, and there seems to be no reason to doubt that similar treatment may have similar results in the case of trees of large growth, though they are not so immediately perceptible. Another contributing cause may be excessive cold. Within the last few years bloodwoods (*Eucalyptus corymbosa*) and other evergreen trees about the head of the Burnett River have been denuded of their leaves by the exceptionally cold weather, and some of them have been killed. In the colder climate of New England the forest trees ought to be accustomed to any amount of frost; but if they have been first weakened by want of rain, then further tried by too great a quantity, their protecting foliage thinned by the trials to which they have been exposed, it is easy to believe that their natural hardihood would not be able to withstand an unusually severe winter, and that in some cases they would die off, while in others they would be so far injured that the appearance which has become so common, of dead branches and a general want of vitality, would be the inevitable consequence.

Against this conclusion it might be reasonably urged that, if this was the true explanation of the natural decay of these forests, the same thing would have happened on previous occasions, and there would not be wanting many evidences that it was so; whereas the only instance I have been able to adduce is that of the so-called lightning-blasted patch on the Europambela run. The force of this contention must be admitted, but its strength rather assists in the confirmation of my views, for it is here that the artificial causes come into operation.

The occupation of the country with stock has brought about considerable changes in its character, and these have become more marked with the excessive stocking which has been commonly practised in late years; for runs that in 1857 were thought to have as many sheep on them as they could fairly carry, have since that time been required to agist 50 or 60 per cent. more without artificial feeding. The effect of this is to keep the grass short and to harden the surface of the soil; consequently, when rain falls it is not impeded by the grass and runs more quickly into the channels and creeks. There is not, therefore, the same amount of soakage into the soil, for the quick flow of the water and the hardness of the trampled ground combine to prevent much absorption, which in a dry season is essential to the health of the trees. Besides this, the ground being hard, and the particles of which it is composed being closely trodden together, it cannot retain the moisture which does penetrate into it with the same readiness as if it was more porous, nor can it contain so much.

A great deal of the New England country is of a slaty formation, and where this is the case the soil is invariably poor. The surface, no doubt, before it was stocked, was largely composed of decayed vegetable matter, the *debris* of falling leaves from the trees and smaller plants; but immediately beneath this there is a bed of poor pipeclay, which after much rain becomes so soft that a horse's feet will immediately sink when he places them over it, and as he draws them out they bring to the surface the white, spuey subsoil; in course of years the trampling of many feet has by this simple process pressed the old surface soil downwards and drawn up the pipeclay to the top. This of course does not apply to the whole of the country, nor even in the same degree to the whole of that which had the white subsoil originally. It is most marked on the flats in the slate country, and these are the home of the peppermint. The Bergen-op-Zoom flats, where the trees first died in large numbers, are of this nature. Now the effect of substituting this new surface, which is so largely mixed with pipeclay, for the former surface, whose chief ingredient was a poor kind of vegetable mould, would be to prevent the rain from penetrating very .quickly, because when dry it works, with trampling, into a very fine powder, and the particles uniting afterwards when moistened form a much more impermeable surface; so that, when the rain falls only in occasional showers, this also contributes to deprive the roots of the trees of the proportion of moisture which they would have received had not the change of surface been effected.

If my theory is well-founded, the peppermints would be the first to suffer, because they do not derive their chief sustenance from the subsoil: their roots spread from the base of the trunk and run along close to the surface, frequently appearing above it. When the moisture, that in ordinary seasons lies on the flats, has evaporated, they feel the want of it at once, and, in the absence of further rain, begin to lose their freshness, while trees whose roots penetrate deeper are able to hold out longer; but all trees which are accustomed in normal seasons to almost unlimited moisture must soon begin to sicken when through any cause they are for long deprived of it.

It is possible that when the trees of a forest have been weakened by a long drought in places where opossums exist in flocks as numerous as sheep, these opossums would eat off all the young shoots, which burst forth when seasonable rains have fallen; but not having yet seen them in such numbers, I find it difficult to speculate on a condition of things which so far surpasses my comprehension.* On New England, in some seasons, thousands of small beetles

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* In order, however, to see how important a factor in the destruction of forest trees these marsupials may be regarded by others, the reader is referred to the ingenious speculations made by the Rev. Peter Macpherson in his paper on "Some Causes of the Decay of Australian Forests" (Proc. Roy. Soc. N.S.W., 1885. Vol. XIX., pp. 83-96).

swarm on the manna gum *(Eucalyptus viminalis)*, and feed upon its leaves to such an extent that after a few weeks scarcely a perfect leaf can be found; and if the opossum theory is to be seriously discussed, surely the claim of these insignificant agents to be responsible for the work of destruction ought not to be overlooked. In considering this matter, however, I have attempted to account for the changes which have been going on without invoking the assistance of either opossums, grubs, or beetles, and in doing so will perhaps expose myself to the derision of those gentlemen who have advocated their claims. Still I believe the question will be satisfactorily settled without such adventitious aid; and if I have been able to suggest anything which will help other inquirers on to the right track, this paper will not have been written in vain.

In conclusion, I would point out that if the theory I have advanced in explanation of the decadence of Australian forests is a sound one, as applied to the localities with which I am familiar, subject to certain modification on account of soil, climate, and general treatment of the country, it would be equally sound in other districts where the trees have sickened and died as they have done in many parts of New England.

THE BIRDS OF CHARLEVILLE;

BY

KENDAL BROADBENT.

(Read on 8th January, 1886.)

[It is with pleasure that I seek this opportunity of laying before the Society the following compilation founded on a perusal of the notes made and on an examination of the specimens procured by Mr. Kendal Broadbent, Zoological Collector of the Queensland Museum, one whose extensive knowledge of the birds of Australia, unsurpassed by few, is well established.—HENRY TRYON.]

WHILST engaged in collecting the animals of the Charleville District, I availed myself of the opportunity afforded of becoming acquainted with the birds which occur there, of most of which indeed I procured examples. The present review relates to such species as are to be met with in this district during the latter part of August and throughout the two succeeding months, and, moreover, in a very dry season. This latter consideration will suggest the fact that this enumeration will include such birds as are permanent residents in the locality of Charleville during the period which my observations embrace, and though it can be regarded as a small contribution only to the avifauna of the district, I am nevertheless persuaded that any information relating to the birds of the interior of Australia, meagre though it be, is worthy of being placed on record.

Charleville is a pastoral township, 520 miles west of Brisbane, on the Warrego River, and is situated in the centre of a generally level country. At the time of my visit the river was represented by a chain of water-holes, miles apart, and fast drying up, connected by a dry river-bed of shingle or sand. This river-bed is often very wide, and includes patches of loamy soil, which at some seasons form islands, on which grow lofty eucalypts, tea-tree *(Melaleuca)*, and other low shrubs of similar habit. The river is bounded on either side, often to the extent of half-a-mile, by flats of dark soil, on which also large eucalypts grow scattered here and there. Beyond this tract of alluvial land, and at a slightly higher level, sandy country occurs, extending parallel to the river. This sand is yielding to the tread and is shifted by the wind. It extends from one to two miles further back. On these sand ridges grow pine trees *(Callitris sp.)*, and eucalypts, especially iron-barks, as well as small acacias and other stunted shrubs. Beyond, and raised two or three feet above the sandy tract, a light red-soiled country is met with. This supports a scrub of a pretty uniform character—the Mulga Scrub, so named from the preponderance amongst its constituent vegetation of the Mulga *(Acacia doratoxylon*, A. Cunn.). In this scrub there are also a few small eucalypts and other trees, and it contains open spots on which grow low and dense bushes. Grass may be plentiful at times in the district, but I have not alluded to its occurrence, as it seemed to have completely disappeared as the result of the severe and long-continued drought. The only trees in flower were the melaleucas, growing in the bed of the river, and a few dwarfed acacias in the sandy soil. In fact the whole scene bore the aspect of a desert, for even the trees appeared to struggle to exist, and the Mulga Scrub, on which the cattle depended for their subsistence, looked dead and was nearly dried up. The birds, except a few parrots, which seemed to have filled their crops with the sticky seeds of the loranthus, a plant which, being a parasite, was somewhat indifferent to the condition of drought, were in a poor condition. No wonder then that they were few in number and little variable in kind. They were as follows:—

1. Aquila audax, *Lath.* The wedge-tailed eagle.

2. Aquila morphnoides, *Gmel.* The little eagle. I shot a solitary bird, the sole example I met with of this species, on the 1st September.

3. Falco subniger, *Gld.* The black falcon. Of this also a solitary specimen was all I saw.

4. Falco lunulatus, *Lath.*

5. Hieracidea orientalis, *Schl.* The western brown hawk.

6. Hieracidea berigora, *V. & H.* A common southern bird but not seen by me east of the Dividing Range; it is frequently met with, however, in the Charleville District.

7. Tinnunculus cenchroides, *V. & H.* The nankeen kestrel. A very uncommon bird in this district. I only saw one example.

8. Astur approximans, *V. & H.* The Australian goshawk. This bird is tolerably common, and breeds in the district.

9. Milvus affinis, *Gld.* The allied kite. Also tolerably common.

10. Lophoictinia isura, *Gld.* The square-tailed kite. Also well represented, and frequenting stock-yards. It breeds in the district, building in the largest trees—white gums—and usually in the neighbourhood of a clump of loranthus.

11. Elanus scriptus, *Gould.* The letter-winged kite. I only met with a solitary example of this bird, which is perhaps nowhere common in Australia, on the 9th September. It was flying high and I was unfortunately unable to procure it.

12. Ninox connivens, *Lath.* The winking owl. This is the common Charleville owl. It breeds here, laying its eggs in a hollow of some large eucalypt, such as grows in the bed of the Warrego.

13. Ninox boobook, *Lath.* The boobook owl.

14. Œgotheles novæ hollandiæ, *Vig.* and *Horsf.*

15. Hydrochelidon nigricans, *Vieill.* The tree-swallow. I saw these birds overhead, flying north, on 24th September and following morning, but did not succeed in procuring a specimen.

16. Lagenoplastes ariel, *Gld.* Common in the township of Charleville, and frequenting the telegraph line.

17. Cheramœca leucosternon, *Gould.* The white-breasted swallow. I met with this bird on 4th Sept., flying high in a northward direction, six or seven in a flock.

18. Merops ornatus, *Lath.* The bee-eater. I met with a flock on 21st August, between Mitchell and Charleville, but did not see them at Charleville itself until 23rd September. They breed in the neighbourhood during October and November, excavating holes for nests in the sand ridges.

19. Eurostomus pacificus, *Lath.* The dollar-bird. The first time I met with this bird in the neighbourhood—where perhaps it is never very common—was on the 3rd October. They remain in the locality for breeding purposes.

20. Dacelo gigas, *Bodd.* The laughing jackass. A common bird here.

21. Halcyon sanctus, *Vig.* and *Horsf.* The sacred kingfisher. This I first met on 24th September. These birds breed in the eucalypts in the river-bed and elsewhere.

22. Halcyon pyrrhopygius, *Gld.* The red-backed kingfisher. This bird breeds at Charleville, and probably remains in the neighbourhood all the year round. It is the common kingfisher of the district. I have never met with it on the opposite side of the Coast Range of Australia.

23. Artamus minor, *Lath.* I first saw the little wood-swallow on the 31st August, when it was met with in flocks. It afterwards occurred in scattered pairs. It remained in the district throughout the period of my visit, and bred on the edge of the Mulga Scrub.

24. Artamus cinereus, *Vieill.* This also breeds in this country, where it was abundant on my arrival. Of the nests which I observed, one was placed in a currajong *(Sterculia sp.)*, and the other in a small pine *(Callitris sp.)*.

25. Artamus personatus, *Gld.* The masked wood-swallow. I saw this bird on 28th August and during the subsequent month only. It flies further south for breeding purposes.

26. Artamus supercilious, *Gld.* The white-eyebrowed wood swallow. The movements of this bird corresponded with those of A. personatus; the two birds accompanying each other in their migrations.

27. Artamus leucopygialis, *Gld.* Was here throughout the period of my stay. It breeds in the locality, frequenting for the purpose the highest gum-trees.

28. Pardalotus rubricatus, *Gld.* The red-lored diamond-bird. This is essentially a bird of the interior. I first saw it on 19th September, after which date it was tolerably abundant. It breeds in the vicinity, utilising for this purpose the burrows of the billbie (*Hypsiprymnus Grayii)*, and always excavates the hole for its nest in some perpendicular portion of them. During the day it frequents the tops of the loftiest eucalypts in company with P. melanocephalus, where it may be recognised by its characteristic call, resembling that of Platycercus pallidiceps—a low sort of whistle, made when stationary in its haunts.

29. Pardalotus melanocephalus, *Gld.* The black-headed diamond-bird. This bird is unlike the P. melanocephalus

of the coast district, and differs from it as do those of the Chinchilla District. It was at Charleville, where it breeds, during my stay.

30. Gymnorhina tibicen, *Lath.* The piping crow-shrike. Commonly met with in this locality, where also it breeds.

31. Cracticus robustus, *Lath.* Common, and also breeds in the district.

32. Cracticus torquatus, *Lath.* The collared crow-shrike. Rather less common than the preceding.

33. Grallina picata, *Lath.* The magpie-lark. Common, as in most parts of Australia. It also breeds here.

34. Graucalus melanops, *Lath.* The black-faced graucalus. Common, after its arrival during the first week of September, and remains in the district to breed.

35. Pteropodocys phasianella, *Gld.* The ground graucalus. This bird of the interior was here on my arrival in August, though not very abundant, in "mobs" of two or three. They almost all disappeared in October. In this district it inhabits the open plains, feeding on the ground. It is, however, very shy, and when disturbed runs off very quickly, and can with difficulty only be made to rise. When it perches, which is usually on some dried branch, it assumes an erect attitude like a bee-eater *(Merops).*

36. Campephaga humeralis, *Gld.* The white-shouldered campephaga is scarce, but breeds in the neighbourhood.

37. Pachycephala rufiventris, *Lath.* The rufous-breasted thick-head. Rather common, and breeds on the edge of the Mulga Scrub.

38. Colluricincla harmonica, *Lath.* The harmonious shrike-thrush. This bird was not very common during my visit.

39. Falcunculus frontatus, *Lath.* The frontal shrike-tit. A very scarce bird here. I saw only two pairs, which had their nests somewhere along the river-bed.

40. Oreica cristata, *Lewin.* The crested oreica. Rather common, especially in barren places.

41. Rhipidura albiscapa, *Gld.* The white-shafted fantail. Not common, and in the Mulga Scrub.

42. Sauloprocta motacilloides, *Vig.* and *Horsf.* The black fantail. Very common.

43. Seisura inquieta, *Lath.* Arrived here on the 4th September, and was not uncommon subsequent to this date.

44. Micræca fascinans, *Lath.* The brown fly-catcher. Commonly met with.

45. Gerygone marstersi. I only saw a few of these birds in this district, where they are not so abundant as at Kimberley, where I discovered them during my visit in 1875, and subsequently met with them in 1884. They are sprightly little birds, having somewhat similar habits to Acanthiza, and frequenting with them the little bushes in the openings in the Mulga Scrub.

46. Smicrornis, sp. Common.

47. Petœca goodenovii, *Vig.* and *Horsf.* The red-capped robin. Common, but I only met with it in the Mulga country.

48. Melanodryas cucullata, *Lath.* The hooded robin. Abundant in the open flats adjoining the river.

49. Malurus melanotus, *Gld.* The black-backed blue wren. I have never before met with this lovely wren, which appears to have been previously found only in the scrubs of the River Murray, where it was observed by Mr. Gould and his coadjutors. It is tolerably common at Charleville, and frequents the openings in the Mulga scrubs, feeding in the little bushes in company with the Acanthiza uropygialis.

50. Acanthiza uropygialis, *Gld.* The chestnut-rumped acanthiza. Pretty common, and frequenting exclusively the Mulga country.

51. Geobasileus chrysorrhous, *Quoy.* and *Gaim.* A somewhat common bird in the openings in the Mulga, and nearly always on the ground, the red soil of which stains the under parts of its plumage.

52. Chthonicola sagittata, *Lath.* The little chthonicola. Somewhat plentiful, and having the same habits and mode of occurrence as the last mentioned bird.

53. Anthus australis, *Vig.* and *Horsf.* The Australian pipit. Owing, perhaps, to the dearth of insect life in such an unfavourable season, this bird was unfrequently met with.

54. Ptenœdus rufescens, *Vig.* and *Horsf.* I only met with a single example of this lark-like bird, with semi-arboreal habits, on the 1st October.

55. Stictoptera bichenovii, *Vig.* and *Horsf.* The double-banded finch, of which I saw a few specimens only.

56. Stagenopleura guttata, *Shaw.* The spotted-sided finch. I only saw a single specimen of this bird.

57. Cinclosoma cinnamomeum, *Gld.* A solitary example was all I saw of this bird.

58. Chlamydodera maculata, *Gld.* The spotted bower-bird. Common, and met with almost everywhere.

59. Mimeta viridis, *Lath.* The green oriole. Is somewhat abundant.

60. Cocorax melanorhampus, *Vieill.* The white-winged cocorax. Troops of this bird are very commonly met with. It breeds in the district.

61. Struthidea cinerea, *Gld.* The grey struthidea. Common, and breeds also in the district.

62. Corvus australis, *Gmel.* The white-eyed crow. Common.

63. Pomatostomus temporalis, *Vig.* and *Horsf.* Common, and breeds in the district.

64. Ptilotis penicillata, *Gld.* White-plumed honey-eater. Tolerably common in the river bed, feeding on the honey of the melaleuca bushes.

65. Plectorhyncha lanceolata, *Gld.* This western and southern honey-eater may be frequently found in company with the above Ptilotis.

66. Acanthogenys rufogularis, *Gld.* The spiny-checked honey-eater. This bird was very common during the period of my stay.

67. Philemon corniculatus, *Lath.* The friar-bird. Very common.

68. Philemon citreogularis, *Gld.* Also common about the river bed.

69. Entomyza cyanotis, *Swain.* Common, and generally distributed.

70. Melithreptus gularis, *Gld.* The black-headed honey-eater. By no means abundant, and frequenting the tops of lofty eucalypts.

71. Myzantha flavigula, *Gld.* This yellow-throated minah, or soldier-bird, entirely replaces M. garrula in this western country, and is as common as the latter is in the districts which it affects.

72. Dicæum hirundinaceum, *Shaw.* The swallow dicæum. Not common, and feeding on the berries of loranthus.

73. Climacteris scandens, *Temn.* The brown tree-creeper. Common in the neighbourhood of the river.

74. Climacteris erythrops, *Gld.*

This dark-coloured creeper, with its conspicuously mottled underparts, is unlike any I have met with in Australia. It was tolerably plentiful in the Mulga scrub, and had the habit—not very general in Climacteris—of feeding on the ground, in which habit it was at Charleville associated with Geöbasileus chrysorrhous.

75. Sitella chrysoptera, *Gld.* The same Sitella which is common in the Chinchilla district, and which is provisionally referred to this species. I only met with a solitary example.

76. Cacomantis pallida, *Lath.* The unadorned cuckoo. These birds were in the Mulga scrub, and were the only cuckoos I saw in the district.

77. Cacatua galerita, *Lath.* The sulphur-crested cockatoo. Common, especially about the sand ridges, where it employs itself in plucking the small branchlets of the eucalypts, after the manner of flying-foxes, either for food of a vegetable description or in quest of insects.

78. Eolophus roseicapilla, *Vieill.* The rose-breasted cockatoo. Very common about the flats on the sides of the river, feeding on grass-roots, or merely pulling them up in order to discover other food, and also on the fruit of the loranthus.

79. Ptistis erythropterus, *Gml.* The red-winged lory. Common, and feeding on berries of loranthus.

80. Platycercus Barnardi, *Vig.* and *Horsf.* Common, and flying between the Mulga country and the river.

81. Psephotus hæmatonotus, *Gld.* Red-rumped parroquet. A common ground-parrot, and feeding on the ground.

All the above Psittacidæ breed in the district. I did not see a single honey-eating parrot.

82. Phaps chalcoptera, *Lath.* The bronze-wing. Frequenting the pine ridges and breeding in the district.

83. Geophaps scripta, *Temm.* The squatter pigeon. Scarce in the district owing to the dry season.

84. Ocyphaps lophotes, *Temm.* The crested bronze-wing. Is a tolerably common pigeon, and breeds in district.

85. Geopelia tranquilla, *Gld.* The peaceful dove. Often met with.

86. Dromaius novæ hollandiæ, *Lath.* The emu. Tolerably common, and feeding on the green tops of a shrub which grows on the sand ridges.

87. Eupodotis australis, *Gray.* The "plain turkey." Common.

88. Ædicnemus grallarius, *Lath.* The night plover.

89. Ægialitis nigrifrons, *Cuv.* The black-fronted dotterell. Often occurring in the river beds.

90. Geronticus spinicollis, *Jameson.* The straw-necked ibis. I only saw two individuals.

91. Threskiornis strictipennis, *Gld.* The sacred ibis. I saw a large flock of these on the 23rd September; harbingers of a slight shower of rain, which fell, and was as quickly absorbed, on the 27th.

92. Ardea pacifica, *Lath.*

93. Ardea novæ hollandiæ, *Lath.* Neither this heron nor the foregoing were at all abundant, even for herons.

94. Chlamydochen jubata, *Lath.* The wood-duck. Commonly frequents the dams along the roads approaching Charleville, in company with the two herons mentioned.

95. Anas superciliosa, *Gmel.* The grey duck.

96. Graculus melanoleucus, *Vieill.* The only shag noticed by me.

EXHIBITS.

By Mr. C. W. De Vis :—Centriscus velitaris, *Pall.* A small fish, concerning which it was remarked that it was cast ashore on the beach opposite Southport, Moreton Bay, and had been transmitted by Mr. V. Macdonald of that place, and that it had proved on inspection to be the species described by Pallas as Amphisile velitaris. In that opinion Mr. de Vis stated that he was fortified by the concurrence of Mr. Macleay; and that the discovery of one at least of its habitats was noteworthy, as Dr. Gunther, in his admirable catologue, had expressed great doubt as to the accuracy of the locality given by Pallas.

FRIDAY, MARCH 5, 1886.

THE PRESIDENT, L. A. BERNAYS, ESQ., F.L.S., IN THE CHAIR.

FORBES' FUND.

Mr. H. Tryon, as Treasurer, drew attention to the state of the Forbes' Expedition Aid Fund. He mentioned that £76 9s. had already been subscribed, and that £63 17s. of this amount had been received; also, that the Queensland Acclimatisation Society and Natural History Society of Rockhampton were contributors to the Fund. On the suggestion of the Chairman it was decided that the Society should also grant towards it a sum of £10 10s.

NEW MEMBERS.

A. T. De Winton, Esq., and W. M. Sutton, Esq.

DONATIONS.

"Transactions of the Seismological Society of Japan." Vol. VIII. Tokio, 1885. From the Society.

"The Victorian Naturalist." Vol. II., Nos. 9 and 10. Melbourne, 1885. From the Field Naturalists' Club of Victoria.

"Contributions to Canadian Palæontology." Vol. I. Montreal, 1885. From the Director of the Geological and Natural History Survey of Canada.

"The Journal of Conchology." Vol. IV., No. 12. Leeds, Oct. 1885. From the Conchological Society of Great Britain.

"Journal of the Straits Branch of the Royal Asiatic Society," 1885. No. 15. Singapore. "Notes and Queries." No. 2. Singapore, 1885. From the Royal Asiatic Society, Singapore.

"The Provincial Medical Journal." Vol. V., No. 49. Jan., 1886. From the Editor, Leicester.

"Catalogue of Plants in the Brisbane Botanic Garden and Bowen Park." Brisbane, 1885; and "Classified Index of the First Supplement to the Indigenous and Naturalised Plants of Queensland, &c." Brisbane, 1886. By F. M. Bailey, F.L.S., Colonial Botanist. From the Author.

"Descriptive Notes on Papuan Plants," by Baron Von Müeller, K.C.M.G., M. & Ph. D., F.R.S., &c. No. 7. Melbourne, 1886. From the Author.

"The Australian Irrigationist." No. 19. Melbourne, 1886. From the Editor.

Photographs of drawings of South American Palms, from Mr. L. A. Bernays.

The following paper was read :—

NOTES ON THE PALM "CARYOTA URENS, *Willd*;"

BY

L. A. BERNAYS, Esq., F.L.S.

(Read on 5th March, 1886.)

On a former occasion I brought to the notice of the Society the Palm "Raphia ruffia," which had proved itself adapted to the climate of Queensland. I now invite your attention to another member of the great palm family, "Caryota urens" (the Toddy Palm), many handsome specimens of which are to be seen at Bowen Park, and elsewhere in the gardens on our coast line. The tree is a native of Ceylon and of the various mountainous parts of India. It grows with a straight column, often sixty feet high and thick in proportion, and is one of the most elegant of the beautiful and widespread family to which it belongs. When in a soil and situation congenial to its nature it grows as fast as the cocoanut tree. The fruit—a berry—is roundish, of the size of a small nutmeg, covered with a thin yellow bark, very acrid to the taste, from which property it derives its specific name "urens." The seed or nut is generally solitary, and is hard enough for buttons and beads, to which use it is applied. The outer wood is nearly as hard as flint, and the stem, freed from the inner pith, makes an economical waterpipe. The wood is used for rafters, but, notwithstanding its hardness, is said not to be durable. The rootwood is hollowed into buckets.

The spathes of the tree yield a palm wine, very pleasant to the palate; and, in the hot season, a single tree will yield ten or twelve gallons in 24 hours. This is used in various ways, either in its fresh state or fermented, and then as an intoxicant or as yeast for making bread. It is also converted into a spirit, and into jaggery sugar.

The inside pith is full of farina; and, yielding a good sago, is largely used as food. The natives convert this farina into bread and boil it into a thick gruel. These articles form a great part of the food of the people where the tree is plentiful; and in times of famine have proved invaluable while the supply lasted. Roxburgh, speaking of the farina, says—"I have reason to believe this substance to be highly nutritious; I have eaten the gruel and think it fully as palatable as that made from the sago of the Malay countries."

From the leaves, which grow 18 to 20 feet in length, is made a fibre which constitutes the great value of the tree. This is known generally in commerce as "Kittool" fibre. In Ceylon a rope of such strength is made from it that it is used for tying wild elephants; from which use it is also known as "elephant" fibre.

Mr. Arthur Ramsbottom, an authority on brush-making, considers "Kittool" fibre as the best substitute yet discovered for bristles, but open to the odd objection, in which none but brushmakers are likely to sympathise, that it is too durable. In the interests of trade it would never do to make an article which was practically indestructible, for this reason the workers for a long time resisted its introduction; but its many excellent qualities have led to its use rapidly spreading. It arrives in the crude state in long hanks or bundles, and is of a dingy black or brownish colour; by steeping it in oil, the fibre is at the same time strengthened and made more flexible, and of a brighter colour. By a steady strain at both ends it can be extended nearly fifty per cent. For brooms it is a soft material, being as good as hair and much more durable. It is also stated that it possesses the further advantage that it can be sold at about a third of the price of ordinary hair brooms, and less than a quarter of that of the best. At Messrs. Bright's works at Rochdale, "Kittool" fibre has been for some time in use with remarkable success, and it is coming into general use in some parts of the United States. The makers also do a considerable trade with the Continent of Europe and the British Colonies.

Other minor uses for the fibre in its own countries are as fishing lines and bowstrings; there is also a woolly material found on the petiole, which is used as oakum in caulking ships. This fibre is by no means a new article of trade in England, having been more or less in use for thirty-five years; and, as it is growing in estimation, and the demand is rapidly increasing, there appears to be a prospect for a new industry in Queensland by its production. If it will pay to grow the cocoa-palm, it is worth considering if the "Caryota urens," a tree of as rapid growth, the leading product of which is easily prepared in its raw state for shipment, may not deserve the attention of our coast farmers.

The "Caryota urens" is fruiting now for the first time at Bowen Park, and, so far as I am aware, for the first time in the colony. It is, like the Raphia Palm of which I spoke last, a prolific bearer; and there will be abundance of nuts from which to raise plants for distribution. A handsome example of the tree may be seen at the corner gates of the Houses of Parliament, opposite the Queensland Club.

EXHIBITS.

By Mr. L. A. Bernays, specimens of different portions of *Caryota urens*, and of products derived therefrom.

By Mr. H. Tryon, the following insects, viz.:—Moths of a species belonging to a genus allied to *Plusia*, the caterpillars of which had recently been destroying the different naturalized and indigenous species of *Amaranthus*, and which appeared to be the Australian representative of the destructive Gamma moth of Europe—*Plusia gamma*, *Linn.*

He also exhibited examples in all stages of a species of *Epilachna*, a voracious beetle usually found feeding on *Solanum nigrum*, but also affecting the tomato, the potato, and other plants of the same natural order. In reference to this exhibit it was pointed out that it was the character of the *Coccinellidæ*, of which *Epilachna* was a member, to occur at times in immense swarms, and that in the event of such an occurrence potato-growers in Queensland would be great losers.

Two other insects were also exhibited by him as being natural enemies to larvæ of the *Epilachna*, viz.:—a small ichneumon, to whose fatal attacks they were especially subject, and a moth (Fam. *Aluctidæ*), whose caterpillar appeared to devour the chrysalis cases.

Mr. G. Watkins remarked that this beetle had already done great damage to potato-growers in the Moreton District.

Mr. H. Tryon also exhibited a worn valve of the shell of a *Trigonia*, found recently at Camboyuro, Moreton Bay, representing a species which he stated to be apparently different from those hitherto described.

FRIDAY, APRIL 2, 1886.

THE PRESIDENT, L. A. BERNAYS, ESQ., F.L.S., ETC., IN THE CHAIR.

FORBES' FUND.

A letter was received from His Excellency the Hon. John Douglas, C.M.G., enclosing a contribution of £5 to the Forbes' Expedition Aid Fund, which it was announced now amounted to £90.

A letter was also received from Mr. W. M'Ilwraith, of Rockhampton, proffering assistance to any members who might be desirous of inspecting the recently discovered caves in that neighbourhood, and Mr. W. D. Nisbet was requested to make his contemplated visit to Rockhampton the occasion of a visit to them.

NEW MEMBERS.

Dr. W. S. Byrne and C. Pritchard, Esq., of Brisbane; and James Tolson, Esq., of Enoggera.

DONATIONS.

"Papers and Proceedings of the Royal Society of Tasmania for 1885." Hobart, 1886. From the Society.

"Annual Report of the Rockhampton Natural History Society," 1885-6. From the Society.

"Bulletin of the American Geographical Society," No. 2. New York, 1885. From the Society.

"Proceedings of the Academy of Natural Sciences." Parts II. and III. Philadelphia, 1884. From the Academy.

"Proceedings of the Boston Society of Natural History." Vol. XIII., Part I. Boston, 1885. From the Society.

"The Victorian Naturalist," Vol. II., No. 2. Melbourne, March, 1886. From the Field Naturalist Club of Victoria.

"Descriptive Catalogue of the General Collection of Minerals in the Australian Museum," by A. F. Ratte. Sydney, 1885. From the Australian Museum.

"Queensland Woods—Catalogue of the Indigenous Woods contained in the Queensland Court of the Colonial and Indian Exhibition of 1886," and "A Synopsis of the Queensland Flora, 1st Supplement," Brisbane, 1886, by F. M. Bailey, F.L.S., etc., Colonial Botanist. From the Author.

"The Australian Irrigationist," No. 20. Melbourne, March, 1886. From the Editor.

"A Journal of Natural Philosophy, Chemistry, and the Arts," by John Nicholson, Vols. 1-12 (in 4 vols.) London, 1802-5. From Mr. J. Cribb, Brisbane.

"Records of the Geological Survey of India," Vol. 19, Part I. Calcutta, 1886. From the Director.

A discussion arose as to the necessity of providing a room—other than that at present available—for the use of the Society, especially in view of its rapidly growing library; and the Chairman referred to the steps which the Council had already taken in order to meet this requirement.

The following paper was read :—

NOTES ON A LIVING TREE STUMP;

BY

A. NORTON, Esq., M.L.A.

It is so commonly supposed that the trunk of a tree cannot long survive if it is not allowed to throw out branches or leaves, that I have thought it desirable to place on record an instance that has come under my own observation where a stump of a tree has continued to live for many years although it has neither branch nor leaf.

The specimen to which I refer is the stump of a Moreton Bay ash (*Eucalyptus tesselaris*), and is on the Rodd's Bay run, at a spot about twenty-three miles from Gladstone, near the main road to Wide Bay. I have lately had it measured, and find that its height is 9 feet 3 inches, and its circumference is 4 feet 6 inches. Its appearance is that of a stump which had been left standing when the upper portion of the tree had been snapped off by a strong wind. The bark has grown over the top edges, but in the centre there is a hollow. With the exception of a small patch on one side the bark is as full of sap as that of an ordinary living tree; but it is simply a stump without any appearance of having at any time had a branch growing from it. I may say that when I first observed it, from fifteen to eighteen years ago, its appearance was just the same as it is now, and there was then no sign of the prostrate head which must at some time have been broken off by the wind or some other agency. Why it should continue to live in its present form is a question to which, though many persons have seen it, none appear to be able to give a satisfactory answer. It is one of the peculiarities of the Moreton Bay ash that its bark spreads over any foreign substance of moderate size which is placed on a living example of it, and instances are not very rare where a dead stick projecting from a surface root is covered up in this way, and presents a somewhat similar appearance to that of the specimen referred to, but on quite a small scale; whenever this happens, however, it is always easy to connect the excrescence with the root of a living tree. But in the specimen under notice no such plausible explanation can be afforded; the size of the stump would of itself upset such a theory; and then there is no other living tree of the same kind in very close proximity to it. I cannot suggest any explanation myself, because none has ever occurred to me which commended itself for acceptance. All I wish to do, therefore, is to record the simple fact in the hope that someone else with more extended knowledge of plant life will throw some light upon it. It would be well perhaps to add that the stump is growing in poor soil, close beside a small blind gully, in which the water after a shower does not last for more than a week or two.

Mr. A. J. Turner endeavoured to account for this unusual occurrence by the supposition that the roots of the tree-stump inosculated with those of saplings or other trees which might be growing even at a distance of many feet, and the foliage of which might affect the elaboration of the sap and the assimilation of the food substance on which the vitality depended.

Dr. J. Bancroft, in reference to the tenacity of life of the spotted gum tree, alluded to a curious instance where a whole tree, its natural attachment to the ground having been severed, had maintained its life by intimate coalescence with the tissues of the branches of two neighbouring trees into which it had fallen.

OBJECTS EXHIBITED.

By Dr. J. Bancroft, a series of photographs of tropical Rhizophora, which had been prepared by his son, Dr. T. L. Bancroft, to illustrate the investigations of the former on the nature of lenticels in plants. This subject the exhibitor enlarged upon, especially with reference to his views as to their respiratory function.

FRIDAY, 7TH MAY, 1886.

THE PRESIDENT, L. A. BERNAYS, ESQ., F.L.S., ETC., IN THE CHAIR.

A letter, in reply to a representation made by the Council, was received from the Under-Colonial Secretary, intimating that the Government had no room available for the use of the Society.

FORBES' FUND.

It was stated that the subscriptions to the Forbes' Expedition Aid Fund amounted to £94 13s. 6d.

NEW MEMBERS.

Messrs. H. L. Davis and R. Rendle, of Brisbane; Dr. Shultze, of Brisbane; and Mr. J. T. Smith, of Toowoomba.

DONATIONS.

"Russkago Geographicheskago Obshtchestva," Tom. XXI., Pt. 6. St. Petersburg, 1886. From the Imperial Russian Geographical Society.

"Mittheilungen der Anthropologischen Gesselschaft in Wien," Vol. XV., Parts 1 and 2. Vienna, 1885. From the Society.

"Journal of Conchology," Vol. V., No. 1. Leeds, 1886. From the Conchological Society of Great Britain.

"The Chemist and Druggist of Australasia," Vol. 1., No. 4. Melbourne, 1886. From the Editor.

"Proceedings of the Linnean Society of New South Wales," Vol. X., Part 4, Sydney, 1886; and "Record of Proceedings," 31st October, 1885. From the Society.

"Proceedings of the Societa Toscana di Scienze Naturali," 15th Nov., 1885, and 10th Jan., 1886. From the Society.

"The Victorian Naturalist," Vol. II., No. 12. Melbourne, 1886. From the Field Naturalists' Club of Victoria.

"Report of the Auckland Institute and Museum for 1885-6." Auckland, 1886. From the Institute.

"Report of the Proceedings of the National Agricultural Society of Victoria for the year 1885." Melbourne, 1886. From the Society.

"On the Figures of Planets," and "On Comparative Temperatures of the Northern and Southern Hemispheres," by Henry Hennessy, F.R.S. From the Author.

"Bericht der Senckenbergische Naturforschende Gesellschaft," 1885. Frankfurt à M., 1886; and "Reisseerinnerungen aus Algerien und Tunis," by Dr. W. Kobelt. Frankfurt à M., 1885. From the Society.

"A Philosophical Treatise on the Earth and its Satellites," by W. Watson. Sydney, 1874. From the Author.

"Journal of the Asiatic Society of Bengal," Vol. LIV., Part 2, No. 3. Calcutta, 1886. From the Society.

"Memoirs of the Manchester Literary and Philosophical Society," 3rd Series, Vol. VIII., London, 1884; and "Proceedings," Vol. XXIII., Manchester, 1884; and Vol. XXIV., Manchester, 1885. From the Society.

"Catalogue of the Echinodermata in the Australian Museum," by E. P. Ramsay, F.R.S.E., &c., Part 1, Echini. Sydney, 1886. From the Trustees of the Australian Museum.

"Queensland, its Resources and Institutions," a series of essays by different authors. Brisbane, 1886. From the Queensland Commissioners of the Indian and Colonial Exhibition.

"Memoirs of the Geological Survey of India," Vols. IV.–XXII. complete; "Records," Vols. I.–XVIII. complete, with Index to Vols. I.–X.; "Palæontologia Indica," Series 2, Vol. I., Pts. 1 (fasc. 1–6), 2–4 and Index; Series 3, Vol. I., Pts. 1–13; Series 5, Vol. II., Pts. 1–4 and 7–10; Series 6, Vol. III., Pts. 1–13; Series 8, Vol. IV., Pts. 1–5; Series 9, Vol. I., Pts. 1–4; Series 10, Vol. I., Pts. 1–5, Vol II., Pts. 1–6, Vol. III., Pts. 1–6; Series 11, Vol. II., Pts. 1, 2, and Index; Series 12, Vol. III., Pts. 1–3, Vol. IV., Pt. 1; Series 13, Vol. I., Pts. 1–3, 4 (fasc. 1–5) and 5; Series 14, Vol. I., Pt. 1, 3 (fasc. 1–5) and 4; Manual of the Geology of India, Part 3. From the Geological Survey of India.

The following paper was read:—

A POST-PLIOCENE ARTIODACTYLE;

BY

C. W. DE VIS, M.A.

(Read on 7th May, 1886.)

(PLATE I.)

BEFORE the advent of the white man and his familiars on Australian soil, there seems to have been no word for pig in the tongue of any native tribe. We must infer that the existence of the animal was unknown throughout the country. It is truly a remarkable fact that New Guinea swine have never, to our knowledge, accomplished the short passage between the northern and southern shores of Torres Straits, or, having done so, failed to establish themselves where the European pig finds it easy to recover and maintain its independence. It must be confessed that Northern Australia is, by reason of its fitful rainfall, not eminently adapted as a whole to the habits of the animal, still its scrubs and river banks would, previous to our occupation of the country, have been able to afford food and shelter to a goodly population of the kind, unless, indeed, native improvidence effected its destruction. What, then, if we assume that a pig or pig-like beast has been a dweller in the land in past time, and has perished utterly from its face? Shall we not be more than ever impressed with the breadth, if not totality, of the eclipse to which the vertebrate fauna of our geological yesterday appears to have been subjected, more than ever curious to know the physical geography, its causes and reactions which wrought the disappearance of a creature so tenacious of life as well as purpose as the pig, yet permitted the descent of a new though weaker world of marsupial life? The assumption is indeed improbable in the ratio of the difficulty it adds to that already felt when we attempt to account for the change from the late to the present, yet it is one which by testimony, reliable as far as it goes, seems to be raised to the higher rank of presumption. That testimony is now submitted for examination.

It consists primarily of a quinque-tuberculate tooth of bunodont type, composed of four sub-conical cusps separated by crucial sinuses and supplemented by a post-basal talon of similar form. Its general shape is that of the last lower molar of the Peccary (D. torquatus), less nearly that of the last upper molar of the native pig of New Guinea (S. papuensis) were its talon brought into the central line of the tooth. It measures 35 mm. longitudinally and 25 mm. transversely, representing, other things being equal, an animal of the size of a large boar. But its immediate kinship was not with the genus Sus.—the multitudinous tubercles bristling on the surface of the tooth in the true pigs and the rising convolutions of enamel forming its complex cusps are entirely absent from the fossil. In the smoothness of the surface and simplicity of the structure of its cusps it even exceeds its homologue in Dicotyles and further departs from it in the comparative regularity of their transverse arrangement.

The outer anterior cusp is, unhappily, broken away. The inner is the largest of those remaining. Its fore and aft measurement is nearly one-half of the whole length of the tooth, its apex being near the hinder end; its two anterior sides, which meet in a low central ridge descending from the apex, slope gently forwards—that on the outer side is sub-concave, the inner one convex. The apex is worn from within downwards and outwards into a triangle of enamel enclosing a similar field of dentine. The hinder pair of cusps are about equal in size, and are placed opposite to each other in the transverse line; the outer one is conical and has its apex worn from without downwards and inwards to an oval patch of dentine; the inner is a little flattened posteriorly, and on its outer and fore sides rendered somewhat angular by projections linking it feebly with its adjoining cusps—its summit shows a surface of abrasion directed inwards and backwards, surmounted by a triangle of dentine. The post-basal talon is a single sub-pyramidal eminence less elevated than the cusps proper, its convex hinder surface culminates in a point or solid angle formed by the junction with that surface of two anterior planes, the outer of which has been flattened by attrition. On the inner side of the tooth a narrow cingulum commences at the fore end of the anterior cusp and ends in the middle of the talon; its edge is irregularly scalloped by the junction with it of ridges descending from the cusps, those from the anterior one being short, broad and two in number, those from the posterior one, three, but long and delicate; the highest point of the edge of the cingulum is opposite the interval between the two cusps. An outer cingulum commencing on the hinder part of the outer side of the hinder cusp terminated on the outer side of the talon, but it is for the most part destroyed.

Confirmatory evidence of the alliance of this Suilline with the Peccaries rather than with the true pigs is given by a lower incisor, the middle tooth of the left side. The crown of this tooth is elongated, pointed, tri-lateral, and incurved, flat on its inner side in adaptation to the adjacent incisor, convex on its outer surface and more curved on the anterior edge of that surface than on the posterior face of the crown. The enamel of the outer surface descends much lower on the edges than in the middle, and thus leaves uncovered a large triangular area of dentine continuous with that of the fang on the inner side. The unprotected dentine runs still higher towards the tip of the tooth, the enamel of the posterior face thins rapidly away as it descends and disappears about midway. It will be seen from this that the enamel clothing of the sides of the tooth is similar in disposition to, but less in extent, than that of the Peccary. The seminude condition of the hinder face of the crown is not repeated in Dicotyles, but even here there is a slight notch in the basal edge of the enamel which may indicate gradual extension from above. The outer edge of the tooth above the base is in Dicotyles incrassated to receive and resist the pressure action of the cusp of the corresponding maxillary tooth, which produces an emargination of its edge. The emargination is present on a larger scale in the fossil, and evidencies a slightly concave condition of the antagonizing surface, but the expansion of the tooth below it is represented in the fossil by a thickening of the enamel only. The cutting edge of the tooth is narrow and curved, the dentine behind it, exposed by attrition, elongated fore and aft. Like the crown, the fang gradually contracts in all its dimensions, it is much compressed transversely, the middle of each of its broad sides is concave, and its anterior edge forms a regular curve, continuous with that of the crown. The total length is 78 mm., of which the crown is 38 mm.; the fore and aft depth is 20 mm., nearly; its greatest transverse measurement, 11 mm. A second specimen, which has lost the crown from above the inner fork of enamel, had a length, when complete, of about 112 mm., or nearly 4½ inches.

The second upper incisor is represented by a tooth from each of the sides and a second of the right side. The crown of this tooth greatly resembles that of the corresponding incisor of Dicotyles. On the posterior side it has the extero-inferior tubercle and the intero-superior tubercle and groove, but the latter is continued upwards to the summit, over which it passes to the posterior surface; a survival of this continuity is extant in Dicotyles. On the outer side the lateral tubercle is strongly demarcated from the adjacent surface by a depressed elongated area. This is reduced in Dicotyles to a linear groove. The edge of the tubercle is entire, not lobed as in the Peccary at its summit. The outer surface is strongly convex. The most interesting feature of this tooth, however, is its large basal vacuity for a persistent pulp, declaring relationship with the progenitors of the hippopotamus. The fang retains to its lower end the triangular shape, and the width given to it by the crown: and its walls are gradually reduced to the thinness conditioned by a persistent matrix. On the fore outer edge of the tooth the enamel descends within 1·5 mm. of the bottom; on the fore inner edge, to the height of 8·5 mm. above it; on the hinder and inner surfaces, it is disposed as in Dicotyles. The length of the tooth is 36 mm.; the breadth of its crown, 12 mm. The second example from the same side as the preceding shows apparently a sexual modification. In proportions, much stouter and shorter, its anterior surface is, towards the summit, obscurely subdivided into an outer and inner lobe. The lateral tubercle is continued upwards as a ridge, slightly folding over backwards. At its base it shows traces of lobular subdivision, and anteriorly it passes into the convexity of the crown without any line of separation. The inner superior tubercle is continuous with the inner subdivision of the anterior surface, and the groove external to it is thus interrupted on the summit of the tooth. Between the apical part of the groove and the top of the outer lateral ridge the apex is ground down to a subtriangular patch of dentine. A third specimen, with its coronal character immature, is also probably from a young male. In all these the pulp cavity is wide and deep. With advancing age, as indicated by wear, it diminishes, though not regularly: the fang concomitantly lengthening below the enamel line and rapidly contracting. In an example, whose crown is eroded to its full breadth, a relatively small conical cavity is left in the much contracted end of the fang. A fifth example shows a larger and deeper cavity, with thinner walls, though more than half the height of the crown is removed by wear; and in a sixth, broken across the implanted end, the cavity was about the same as in the fourth specimen, though the crown is less reduced by wear. It would seem, then, that these teeth maintain a waning activity of growth throughout life, or at least during their functional period; the gradual eruption so effected compensating, perhaps, for terminal loss by wear as in the canines.

A portion of the crown of a compressedly triangular tusk, longitudinally striated and transversely marked with downward curving lines of growth, represents, apparently, the left lower canine. Its hinder face, worn smooth by friction with the fore edge of the upper tusk, curves a little outwards and gradually widens as the curve of its inner border diminishes in its ascent. Its summit is obliquely truncated inwards, downwards, and backwards. There is no enamel on this face of the tusk, even below the worn surface, where in the Peccary it turns backwards from the outer and inner faces to cover the base posteriorly. The hinder side of the lower end of the outer face is impressed with a broad groove, as in Dicotyles; in the latter, the groove is bounded anteriorly by a strong enamel ridge descending from the enamelled surface above the basal dentine. The fossil fragment shows only the upper part of this ridge, where it subsides into the general surface, and even here it is only to be traced by a faint groove on its anterior side.

Viewed in front, the tusk has an outward curve, as in the Babirussa. The inner surface is broad, a little convex fore and aft, and obliquely curved longitudinally. There are no signs of ridges at the lower end. Their absence, both from the outer and inner sides, indicates that the fossil is the subterminal part of the tusk. If so, the abrasion of the hinder surface did not extend so low upon the tusk as in Dicotyles, in other words, the upper and lower canines did not antagonise so completely.

Assuming that these fossils will be found to typify a new genus of the extinct Suillines, I venture to propose for it the name Prochœrus, with the specific limitation *celer*, both terms in allusion to its occupation of the country before the true pigs. The comparative frequency of its teeth shows that it was not altogether a rare member of the post-pliocene fauna.*

EXHIBITS.

The President exhibited on behalf of the Colonial Botanist —Fruit of Eleocarpus bancrofti, *Bail.* and *F. v. M.*, a tree productive of excellent timber and an edible fruit; the ribbed fruit of Ficus pleurocarpa, *F. v. M.*, probably a valuable timber tree; pods, &c., of Cassia brewsteri, *F. v. M.*, medicinal; fruit of Tarrietia trifoliolata, *Bail.*, a large timber tree; bark of Daphnandra aromatica, *Bail.*, a new spice bark; foliage of Grevillea pinnatifida, *Bail.*, extremely ornamental—the wood, one of the most beautiful of Queensland woods; screw-like pod of Archidendron Vaillantii, *F. v. M.*, a timber tree. Most of the trees of which these illustrations were exhibited were stated to be growing at the Johnstone River.

* The "quinque-tuberculate tooth of bunodont type" was obtained at Sharrow, and the remaining fossils at other localities on the Darling Downs.—Ed.

Mr. A. Norton exhibited samples of a schistose rock from Gladstone, likely to prove of economic value as a flag-stone.

A fine pair of Phalacrognathus Mülleri, *Macl.*, the recently described lucanid beetle from North Queensland; a set of native grinding stones from the neighbourhood of Goondiwindi, sent by P. W. Pears, Esq.; and the contents of the gizzard of an Ibis, among which are large grains of gold, were shown by Mr. De Vis, who also exhibited the fossils illustrating his paper, and skulls of Dicotyles, Babiroussa, and the pig of New Guinea.

FRIDAY, 4TH JUNE, 1886.

THE PRESIDENT, L. A. BERNAYS, ESQ., F.L.S., ETC., IN THE CHAIR.

FORBES' FUND.

Mr. H. Tryon, the Treasurer of the Forbes' Expedition Aid Fund, stated that the subscriptions promised towards the Fund amounted to £142 17s. 6d., and that a greater part of this sum had been received.

NEW MEMBERS.

Dr. W. C. C. MacDonald, Ingham, and Mr. E. B. Lindon, A.R.S.M., Brisbane.

DONATIONS.

"Russkago Geographeskago Obshtchestva," Tom. XII., Pt. 1. St. Petersburg, 1886. From the Sociéte Imperiale Russe de Geographie.

"Transactions and Proceedings of the Botanical Society of Edinburgh," Vol. XV., Pt. 2. Edinburgh, 1885. From the Society.

"Journal of the Bombay Natural History Society," Vol. I., No. 2. Bombay, 1886. From the Society.

"Natuorkundig Tydschrift voor Nederlandsche-Indie." Deel. XLV. Batavia, 1886. From the Natural History Society, Batavia.

"Descriptive Notes on Papuan Plants," No. VIII., by F. von Mueller, K.C.M.G., F.R.S., Ph. and M.D., etc. Melbourne, 1886. From the Author.

The following papers were read:—

ON THE PRESERVATION OF PERISHABLE ARTICLES OF FOOD BY REFRIGERATION;*

BY

JAMES TOLSON, ESQ.

(Read on the 4th June, 1886.)

(PLATE II.)

IN the paper which I now have the honor to bring under your notice, I have endeavoured to put into as concise a form as possible, a few remarks on the preservation of perishable articles of food by means of cold air. As far as can be ascertained, no attempt has yet been made to bring this most important branch of mechanical work under scientific control. The laws governing the compression and expansion of air, the transmission of heat, and the cooling of heated bodies, are but little understood by the majority of working engineers, and the causes which bring about decomposition in organic substances almost less so. What I am now attempting, is the preliminary gathering together of such information as, by directing inquiry into the proper channels, shall thereby lead up to a more comprehensive and scientific treatment of the substances we wish to preserve by the above-named process.

The importance of the subject, as well as the necessity for the more general adoption of this method of food preservation, is such as cannot be denied, even by those who look at it only from the narrow point of view of their

*The works referred to in the subsequent pages for the several statements quoted are—

Tyndall: "Heat Considered as a Mode of Motion." London, 1868.
Ganot: "Traité Eleméntaire de Physique." Eng. Trans. London, 1881.
Balfour Stewart: "An Elementary Treatise on Heat." Oxford, 1881.
Box: "A Practical Treatise on Heat." London, 1880.
Schützenberger: "Fermentation." London, 1876.
Rankine: "The Steam Engine." London, 1882.

own immediate wants and requirements. When, however, we come to consider the matter in a broader and more general sense, it is then that the great capabilities of the subject become evident, and it is seen to be of national importance.

The late Sir J. P. Bell stated, and probably with truth, that the time would come when the export of meat would approach in value that of wool; and when we look at the great and increasing populations in Europe, with their food supply already insufficient, as evidenced by the enormous and ever-increasing importations from America and elsewhere, we cannot but be struck by the truth of his remarks.

A careful study of the price-lists of meat imported from America, and the consideration of the cost of its production in the great cattle-raising States, make it evident that beef and mutton can be grown here at as small a cost as in any of these countries, especially when regard is had to the prices at which cattle and sheep are sold by the growers in these colonies. Up to the present time, the greatest drawbacks to a successful development of such a trade seem to be, not in the supply being deficient, or the quality inferior, but in the difficulties of preparation and transport, and the cost of conveying the chilled meat to the place of consumption. Not the least difficulty, however, is to be found in the want of scientific knowledge on the subject of refrigeration and preservation in all its branches. This lies at the very root of the matter, and before any successful attempt at refrigeration can be made, it is necessary to have some knowledge of the causes which produce decomposition and putrefaction; of the laws which govern the transmission of heat, and the process of cooling; what heat itself is, and how it operates in the preservation or otherwise of perishable articles of food; and what is the action of cold, or, in other words, the absence of heat. All these questions should be carefully considered, as, without a precise knowledge of the various and complicated actions of nature, any work attempted in the above direction is simply striking at random, or, at best, working upon some antiquated and obsolete theory, which will mislead our endeavours, and bring about failure and loss. Also, in the construction of buildings for the purpose of refrigeration, a great want of scientific knowledge exists, and accordingly much money has been uselessly expended on them.

In the following notes, in which are incorporated extracts from the works of our most eminent scientific writers on the subject of heat, I have endeavoured to bring together the information necessary to form a clear conception of what heat is and the processes with which we have to deal whenever we deprive a body of its heat. The most recent views also on decomposition and putrefaction are glanced at as dealing with a subject that seems to be almost neglected, though involving considerations of the utmost importance to the successful carrying out of the work. Special attention should be directed to them by all who are making the subject a study. A clear conception of the laws which govern these processes can be obtained without any great amount of study, and my aim is to bring into as compact a form as possible the leading principles, leaving the scientific explanation of them for the after investigation of those who wish to obtain a deeper insight into the subject.

It will be convenient to deal with the subject under the following heads :—

1. The nature of heat, including its transmission and the laws of cooling.

2. Decomposition and the germ theory.

3. Refrigeration practically applied.

HEAT.—" Heat," in the language of Tyndall, " is not the clash of winds ; it is not the quiver of a flame, nor the ebullition of water, nor the rising of a thermometric column, nor the motion which animates steam as it rushes from a boiler in which it has been confined. All these are mechanical motions into which that of heat may be converted ; but heat itself is molecular motion. The molecules of bodies, when closely grouped, cannot, however, oscillate without communicating motion from one to another, and it is the propagation of the motion of heat from molecule to molecule to which we must devote our attention.

" Ideas concerning the nature of heat have recently undergone a great change. Formerly this agent was regarded as a species of matter, but of the class of imponderables, since no evidence of the weight of heat could be obtained, inasmuch as a hot body does not weigh more than the same body when cold ; but very lately scientific opinion has unanimously decided that heat is not a kind of matter, but a kind of energy."—Stewart, op. cit.

"The condition of heat is a condition of energy; that is, of capacity to effect changes.

"The condition of heat, considered as a kind of energy, is capable of being indirectly measured, so as to be expressed as a quantity, by means of one or other of the directly measurable effects which it produces. When the condition of heat is thus expressed as a quantity, it is found to be subject, like other forms of energy, to a law of *conservation* ; that is, if in any system of bodies no heat is expended or produced through changes other than changes of temperature, then the total quantity of heat in the system cannot be changed by the mutual actions of the bodies, as what one body loses another gains, and if there are changes other than changes of temperature, then if by those changes the total heat of the system is changed in amount, that change is compensated exactly by an opposite change in some other form of energy."—Rankine, op. cit.

"The heat of a body is caused by an extremely rapid oscillating or vibrating motion of its molecules, and the hottest bodies are those in which the vibrations have the greatest velocity and the greatest amplitude. At any given time the whole of the molecules of a body possess a sum of *vis viva*, which is the heat they contain. To increase their temperature is to increase this *vis viva* ; to lower their temperature is to decrease this *vis viva*. Hence on this view heat is not a substance, but a *condition of matter*, and a condition which can be transferred from one body to another. When a heated body is placed in contact with a cooler one, the former cedes more molecular motion that it receives, but the loss of the former is the gain of the latter. In *solids* the molecules have a kind of vibrating motion about a certain fixed position. This motion is probably very complex; the constituents of the molecule may oscillate about each other besides the oscillation of the molecule as a whole, and this latter may be a to-and-fro motion, or it may be a rotatory motion about the centre. In cases then in which external forces, such as violent shocks, act upon a body, the molecules may permanently acquire fresh positions. In the *liquid* state the molecules have no fixed positions. They can rotate about their centre of gravity, and the centre of gravity itself may move. But the repellant action of the motion compared with the mutual attraction of the molecules is not sufficient to separate the molecules from each other. A molecule no longer adheres to particular adjacent ones, but it does not spontaneously leave them except to come into the same relation to fresh ones as to its previous adjacent ones. Thus, in a liquid there is a vibratory, rotatory, and progressive motion. In the *gaseous* state the molecules are entirely without the sphere of their mutual attraction. They fly forward in straight lines, according to the ordinary laws of motion, until they impinge against other molecules, or against a fixed envelope which they cannot penetrate, and they return in the opposite direction with, in the main, their original velocity. If the molecules were in space where no external force could act upon them they would fly apart and disappear in infinity. But if contained in any vessel the molecules impinge in all directions against the sides and thus arises the pressure which a gas exerts on its own vessel."—Ganot, A., op. cit.

The original source of all heat or energy is the sun, and when we come to examine the heat of any body we are simply noting the amount of the energy which has been exerted upon its molecules, according to the particular manner in which that energy was stored. In fuel, for example, the energy of the sun's rays has acted upon the leaves and stems of plants, and, in conjunction with the so-called vital forces, has produced those vegetable compositions which retain their chemical constituents in such a form that by bringing the oxygen of the air into contact with them we can induce docomposition and thereby release as much energy as was originally expended in building them up. This energy appears as heat, and we simply transfer a portion of the original heat or energy, which was given out by the sun to the plants forming the fuel we are burning, to the substance we wish to heat; this again is dissipated into space or absorbed by other bodies, and so through increasing changes, but without loss, so far as the whole universe is concerned. In food, which has the same origin as fuel, we find the energy of the sun's rays stored up in the manner best suited to the requirements of the organism for which it is intended.

"Vegetables serve to transmute the energy of the sun's rays into fuel and food. Animals, again, consume this food and transmute it partly into useful work and partly into the degraded form of diffused heat."—Stewart, op. cit.

If the "Dynamical Theory," as it is called, be accepted as correct, and the evidence in its favour is simply overwhelming, it will be clearly seen that any form of energy which produces molecular motion also produces heat, and that, so far as the substance heated is concerned, the result is identical by whatever means the motion is produced. Consequently, "animal heat" does not differ *in kind* from the heat produced by any other form of energy, being heat developed in the body of a living animal as the result of chemical separation, etc. To those unacquainted with the operations of the laws governing the changes of state which occur when chemical decomposition takes place, it would seem to be of a different order to the heat generated by, say, a fire, or a steam pipe. Such is, however, not the case, as, if "animal heat" were other than dynamical, its action would not be manifested in the same manner, and we should require other means and apparatus to detect it. As, however, all its indications and manifestations are perfectly in accordance with, and capable of being referred to, the dynamical theory, and produce exactly the same results upon the animal tissues as those produced by the ordinary forms of energy, we are justified in stating that there is no difference *in kind* between "animal heat" and any other heat. Nor is it conceivable that there could be any, for if we trace the operations of the vital processes, we find that the "animal heat" is produced by three distinct forms of energy, all of which exist and operate in exactly the same manner outside of an organised body as in it. These forces, or forms of energy, are the energy of chemical separation, the energy of absorbed heat or friction, and the energy of electrical separation. Although the vital power which calls these energies into play in a living body is undiscoverable and totally beyond our present comprehension, still we can produce exactly the same results with inorganic compounds, generate heat by friction or electricity, and measure with great accuracy the amount of heat (or motion) produced.

Box, in his treatise on heat, makes the following remarks on this subject :—

"In the act of respiration, oxygen derived from the atmospheric air combines with carbon and hydrogen given out from the lungs, the carbon being transformed into carbonic acid and the hydrogen into water or vapour. It is shown that combustion, by which heat is obtained in our furnaces, is effected by similar combinations, so that respiration is a veritable act of combustion at a low temperature, and an amount of heat is produced proportional to the carbon and hydrogen consumed. According to M. Dumas, an ordinary man burns per hour a quantity of carbon and hydrogen equivalent to .022lb of carbon, and the heat developed will be $12{,}906 \times .022 = 284$ units per hour. The heat thus developed serves to keep up the temperature of the body. If there were no means to prevent its accumulation the temperature would rise without limit, but such means are provided, and are so nicely adjusted that the body is maintained uniformly at 98° under all circumstances. The surplus heat is carried off—1st, by radiation to cold walls or other surrounding objects; 2nd, by contact of cold air; and 3rd, by perspiration, in which the fluids of the body are vapourised and heat becomes latent. With moderate temperature all three of these means are in operation, and only then is perfect comfort experienced. · In extreme cold perspiration is nearly suppressed and all the heat is carried off by radiation and contact of cold air. When the temperature becomes moderate, *insensible* perspiration ensues and the skin becomes moist. As the temperature rises the amount vapourised becomes progressively greater, and when air and walls have attained the temperature of the body, or 98°, the loss of heat by radiation and contact of air is suppressed, and the whole of the animal heat has to be carried off by perspiration, which then becomes excessive and takes the form of sweating."—Box, op. cit.

TRANSMISSION OF HEAT AND LAWS OF COOLING.—"The cooling of heated bodies may be effected in three ways—(1) By radiation, (2) by contact of cold air, and (3) by conduction. Putting U for the total loss from all causes, and R A and C, for the respective losses by radiation, contact of cold air, and conduction we have $U = R + A + C$."—Box, op. cit.

RADIATION.—At an early stage in the history of radiant heat, the following question arose:—A hot body, we all know, radiates heat towards those bodies which are of a lower temperature than itself, but *does it also radiate* when surrounded by bodies of a temperature equal to its own, or of a higher temperature? In other words, is the radiation of a given body at a given temperature dependent upon those bodies which surround it, or is it independent of them?

Nearly a century ago Professor Prevost, of Geneva, propounded the latter theory, and since that time it has been gaining ground as the one most consistent with all observations. It has been developed by many eminent scientists, and is now universally accepted as correct, and may be stated as follows :—

"All bodies are constantly giving out radiant heat at a rate depending upon their substances and temperature, but independent of the substances and temperature of the bodies that surround them. Take, for instance, a thermometer hung in an enclosure; this, according to Prevost's *Theory of Exchanges*, as it is called, is constantly giving out heat at a rate depending upon the temperature of the bulb, and independent of that of the surrounding enclosure. On the other hand it is receiving heat from this enclosure at a rate depending upon the temperature of the enclosure, and independent of that of the bulb. Thus its heat expenditure depends upon its own temperature, its heat receipts upon that of the enclosure, and there is equilibrium when its expenditure is exactly balanced by its receipts.

"Radiation takes place in vacuo as well as in air, for it takes place between the sun and the earth, and between the fixed stars and the earth, and we have no reason to think that all space is filled with some kind of air. Radiation takes place equally on all sides. If a sphere be heated and very delicate thermometers be placed on different sides of such a sphere at equal distances, they will always give the same indications."—Stewart, op. cit.

"Radiant heat is capable of passing through certain substances without sensibly heating them. Atmospheric air and rock-salt may be quoted as two examples of bodies very slightly affected by radiant heat.

"Radiant heat, like light, is capable of being reflected, the metals being the best reflectors. The following table shows the proportion of reflected rays in every 100 from some of the metals in ordinary use. For example, out of every 100 rays falling upon the surface of a plate of polished silver at an angle of 50°, 97 of them are reflected; from brass, 93; from steel, 82; from zinc, 81; from iron, 77."—Ganot, op. cit.

"It has been found that the absorbing power of a body varies inversely to its reflecting power, and thus a good reflector is a bad absorber and *vice versa*. The absorbing power of a body is its property of allowing a greater or less quantity of the heat which falls upon it to pass into its mass. The radiating power of a body is its capability of emitting at the same temperature and with the same extent of surface greater or less quantities of heat."—Ganot, op. cit.

Although the identity of the absorbing and radiating powers of a body cannot be accurately deduced from its reflecting power, because the two are not exactly complementary, still from experiments made by Dulong and Petit there is strong evidence that they are so. All experiments made for the purpose show that those substances which are good radiators are also good absorbers, and it is therefore concluded that the radiating power is equal to the absorbing power for the same body, and for the same difference between its temperature and the temperature of the surrounding medium. It follows, therefore, that causes which modify the absorbing powers will modify the radiating powers also; and as the reflecting power varies in an inverse manner to these, whatever increases it diminishes the radiating and absorbing power, and *vice versa.*

The following table, taken from the work of M. Ganot, gives the relative radiating and absorbing power of various substances as compared with lampblack; lampblack being taken as the standard of comparison, as it absorbs all the rays falling upon its surface, reflecting none.

Lampblack - -	100	Tarnished Lead -	45
Whitelead - -	100	Polished Lead -	20
Paper - - -	98	Polished Iron -	15
Ordinary White Glass	90	Tin, Copper, Gold, &c. - - -	12
Isinglass - - -	80		

From experiments made by Balfour Stewart on radiant heat, he found that—

"Radiation goes on in the interior of a body just as much as at the surface, and that in the interior of substances, as well as in air or in vacuo, a stream of radiant heat is constantly passing and repassing in all directions; and in a case of constant temperature, as this stream of heat passes any layer of particles, it is just as much diminished by the absorbing action of these particles as it is recruited by their radiation, so that the stream flows on virtually unchanged both in quantity and quality, until it at last reaches the surface."

And that, according to the theory of Prevost—

"1st. If an enclosure be kept at a uniform temperature, any substance surrounded by it on all sides will ultimately attain that temperature.

"2nd. All bodies are constantly giving out radiant heat, at a rate depending upon their substance and temperature, but independent of the substance and temperature of the bodies that surround them.

"3rd. Consequently, when a body is kept at a uniform temperature, it receives back just as much heat as it gives out."—B. Stewart, op. cit.

Different substances radiate and absorb very different amounts of heat, and it has been a work of some difficulty to ascertain correctly the variation in their absorbing and radiating powers. Mr. Peclêt, who studied the question with great care, gives a table of the radiating and absorbing power of the following substances in units of heat emitted or absorbed per square foot per hour, for a difference in temperature of 1° Fahr. between the substance and the surrounding bodies. Thus, if a cubic foot of polished silver in vacuo be heated, say, to 60° Fahr., and kept uniformly at that temperature, and the temperature of the surrounding bodies be 59°, there will radiate from every square foot of surface of the silver as much heat as would warm 1 lb. of water, at 59° Fah. 0·02657 degrees; or, to speak more accurately, the difference in the amount of heat radiated *by the* square foot of silver, and the amount absorbed *from* the surrounding objects will be sufficient to heat 1 lb. of water 0.02657 degrees.

The following table, taken from Mr. Box's work previously cited, gives the value of R, or the radiating and absorbing power of substances in ordinary use, and denotes units of heat emitted or absorbed per square foot per hour, for a difference in temperature of 1° Fah., from the experiments of Mr. Peclêt:—

TABLE 1.—VALUE OF R.

	Value of R.
Silver, polished	·02657
Copper	·03270
Tin	·04395
Zinc and Brass, polished	·04906
Tinned Iron	·08585
Sheet Iron	·09220
Lead	·1328
Iron, ordinary	·5662
Glass	·5948
Cast Iron, new	·6480
Chalk	·6786

	Value of R.
Cast and Sheet Iron, rusted	·6868
Wood Sawdust, fine	·7215
Building Stone, Plaster, Wood, Brick ...	·7358
Sand, fine	·7400
Calico	·7461
Woollen Stuffs, any colour	·7522
Silk Stuffs, Oil Paint	·7583
Paper, any colour	·7706
Lampblack	·8196
Water	1·0853
Ice	·55
Oil	1·4800
Meat	1·25

Transparency of Atmospheric Air to the Rays of Radiant Heat.—"Atmospheric air has the remarkable property of allowing radiant heat to pass through it without being sensibly heated thereby. In experimenting upon this property, Tyndall found that the more refined the method used, and the more delicate the apparatus with which he worked, the less noticeable was the absorption. We are therefore entitled to say that air is transparent to heat rays, and that heat can pass through a moderate thickness of air or gas without appreciable loss or heating the air sensibly, so that in ordinary cases air and gases cannot be heated directly by radiant heat, but only by contact with heated bodies."—Box, op. cit.

Tyndall, in his work on heat, writes in reference to the transparency of dry air to radiant heat :—

"A joint of meat might be roasted before a fire, the air round the joint being cold as ice. The air on high mountains may be intensely cold while a burning sun is overhead; the solar rays which, striking the human skin are almost intolerable, are incompetent to heat the air sensibly, and we have only to withdraw into the shade to feel the chill of the atmosphere. Immersion in the shadow of the 'Dome de Gouté' at once changed our feelings, for here the air was at freezing temperature. It was not, however, sensibly colder than the air through which the sunbeams passed, and we suffered, not from the contact of hot air, but from radiant heat which reached us through an ice cold medium."

Dr. Hooker, in his "Himalayan Journal," as quoted by Tyndall, writes—

"At 10,000 feet, at 9 a.m., I saw the mercury rise to 132° Fahr., while the temperature of the shaded snow hard by was 22° Fahr. At 13,000 feet elevation the thermometer has stood at 98° in the sun and at 29° 8′ in the shade, and an hour later 114° in the sun with a shade temperature of 32° 6′."

Again, in the polar regions in the summer time the pitch has been observed to run from the seams in the vessel's side, while the thermometer in the shade close by has stood below freezing. Had the air the power of absorbing radiant heat to any appreciable extent, it is quite evident that such differences in temperature as those above cited could not have occurred.

But while dry air is thus shown to be almost perfectly transparent to heat rays, the aqueous vapour suspended in it acts in a very different manner. The following experiment of Tyndall's may also be mentioned as showing the difference between the absorptive power of dry air and aqueous vapour. Testing dry air for its absorptive power, he first experimented with a vacuum. A long tube was mounted with rock-salt ends, and the air from the interior withdrawn by means of an air pump. A body radiating heat at a constant temperature of 212° Fahr. was then fixed in such a manner that the heat rays emerging from it and passing through the rock-salt ends of the tube fell upon a galvanometer at the other end. This was carefully adjusted and the number of degrees the index moved was noted. Dry air was then admitted, and the heat rays, as before, passing through the rock-salt ends, had now the air to traverse before falling upon the galvanometer. A movement of less than 1° was perceptible, the index then remaining stationary. The dry air was then withdrawn by means of the air pump, the galvanometer again noted, and the ordinary atmospheric air from the room allowed to fill the tube. Although the amount of aqueous vapour in the air was only 45 per cent. of the amount capable of being carried at the temperature noted, a deflection 72 times as great as that from the dry air was produced, thus showing that the aqueous vapour suspended in the air exercised an absorptive power more than 72 times as great as that of the air itself.

Loss of Heat by Radiation.—"1. Let P (in fig. 1, plate II) be a block, say, of building stone, 1 foot cube, having its surfaces, SS, as also the air in contact with it, maintained at a constant temperature of 60° F., and let these surfaces be exposed to distant walls, WW, maintained at 59° or 1° lower than SS.

"Under these circumstances the surfaces, SS, will obviously lose no heat by contact of cold air because the air has the same temperature as itself; for a similar reason there will be no loss by conduction because P has the same temperature all through; but SS will send out in all directions towards WW rays of radiant heat, which will proceed in straight lines through the air until they are intercepted and absorbed by the walls. The amount of heat thus lost will vary exceedingly with the nature of the surfaces. Thus according to the Table 1, which gives the loss in units of heat per square foot per hour, for 1° difference between S and W, as in this case, for building stone, this loss may be taken at ·736 units per hour. If W had the same temperature as S, radiation would cease altogether; if, on the other hand, the temperature was reversed, S being in that case 1° *lower* than WW, it would absorb the same amount of heat as it emitted in the former case; the radiating and absorbing power of bodies being equal to each other.

"For ordinary atmospheric temperatures of absorbing surfaces, say 40° F., and *small* differences between S and W, we may admit that the loss of heat is simply proportional to that difference, but for high temperatures and great differences between S and W, the loss of heat is much greater, following a complicated law from which Dulong has given a rule that agrees very well with experiments.

"The loss of radiant heat is not affected by the form of the radiant body—a cube, a square, or a cylinder, etc., will radiate the same amount with equal areas under the same conditions, so long as the body is not of such a form as *to radiate to and from itself*.

"The colour of the surface seems to have no effect on the radiant power of bodies, at least this is true of paper and woven fabrics.

"The radiation of heat is not affected by the distance of the absorbent. If the space were a vacuum it would be quite immaterial whether WW were inches or millions of miles distant from S, the rays of heat would travel on until they were absorbed by some cold body that intercepted them. Thus, the heat we receive from the sun is radiant heat that has travelled 92 millions of miles through space."—Box, op. cit.

"Newton was the first to enunciate his views on the cooling of bodies. He supposed that a heated body exposed to a certain cooling cause would lose at each instant a quantity of heat proportional to the excess of its temperature above that of the surrounding air. It was, however, soon found that this law was not exactly followed, and many experiments were made on the subject with more or less success until the time of MM. Dulong and Petit, who made a very complete and successful investigation of the velocity of cooling of a thermometer both in vacuo and in air."—Balfour-Stewart, op. cit.

Without going into the details, which are very difficult and complicated, and which may be found it Stewart's work on heat, Messrs. Dulong and Petit found that—

"1st. The loss of heat varies with the *absolute* temperature of the absorbent, so that, for example, if the temperature of WW in fig. 1 had been 212°, and that of S = 213°, the loss of heat would have been nearly double the amount with the respective temperatures 59° and 60°.

"2nd. That the loss of heat increases also in a much more rapid ratio than the difference of temperature; thus, with 432° difference, and with the absorbent at 212° (the radiant being in this case 644°), the loss is six times greater than at the lower temperature first given."—Box, op. cit.

By putting Dulong and Petit's rules into such a form as to give a *ratio*, these calculations may be expressed as follows:—

$$\frac{124{\cdot}72 \times 1{\cdot}0077^{t} \times (1{\cdot}0077^{T} - 1)}{T} = R''$$

Where t = the temperature of the absorbent of the radiant heat in *degrees centigrade;* T = the *excess* of temperature of the radiating body in degrees centigrade, and R″ = the *ratio* of the loss of heat under the given temperature. The constant 124·72 is given by Peclêt, who found the rule to agree perfectly with his own experiments. As an example, if the temperature of the absorbent be 59° F. or 15° C., and the *excess* of temperature of the radiant above the absorbent be 180° F., or 100° C., then—

$$R'' = \frac{124{\cdot}72 \times 1{\cdot}0077^{15} \times (1{\cdot}0077^{100} - 1)}{100}$$

$$= \frac{124{\cdot}7 \times 1{\cdot}122 \times (2{\cdot}153 - 1)}{100}.$$

$$= 1{\cdot}613 = \text{ratio of loss of heat.}$$

If the radiant, for example, be cast iron, whose radiating power is ·6480 by table No. 1, the rate at which it loses heat, for a difference of 180° F., will be ·6480 × 1·613 = 1·045 units per square foot per hour for 1° *difference* in temperature between the walls of the enclosure and the radiant; and as in this case the difference in the temperature between them is 100° C., or 180° F., we have $1{\cdot}045 \times 180 = 188{\cdot}1$ units as the quantity of heat radiating per square foot per hour from the surface of cast iron, if it be kept at a constant temperature.—Box, op. cit.

In the case where the temperature of the absorbent is below zero centigrade, the formula becomes,

$$R'' = \frac{124{\cdot}72 \times 1{\cdot}0077^{-t} \times (1{\cdot}0077^{T} - 1)}{T}$$

$$= \frac{124{\cdot}72 \times \frac{1}{1{\cdot}0077^{t}} \times (1{\cdot}0077^{T} - 1)}{T}.$$

In which $-t$ = the number of degrees below zero centigrade of the absorbent. As an example, take a body at a temperature of 95° F. or 35° C., hanging in a freezing room, the walls of which are at $-13°$ F. or $-25°$ C., the formula then becomes—

$$\frac{124{\cdot}72 \times 1{\cdot}0077^{-25} \times (1{\cdot}0077^{60} - 1)}{60}$$

$$= \frac{124{\cdot}72 \times \frac{1}{1{\cdot}214} \times (1{\cdot}584 - 1)}{60}.$$

$$= 1{\cdot}004 = \text{ratio of loss of heat.}$$

Taking meat, at a temperature of 95°, as an example, having a radiating power of, say, 1·25 (by Table No. 1), the loss per square foot, for a difference of temperature between the walls and the meat of 108° F. or 60° C., would be at the rate of $1{\cdot}25 \times 1{\cdot}004 \times 108 = 135{\cdot}5$ units per square foot per hour at the *commencement.* As, however, the supply of heat in the meat is only limited, and it is not kept up, the radiation falls off from the first moment, until it finally ceases, when the temperature of the meat and the walls are the same.

The following table gives the *ratio* of the loss of heat by radiation, for temperatures from $-40°$ to 104° Fah. of the absorbent, which in our case is the wall of the freezing chamber, and with a difference of from 9° to 135° Fah. in the *temperature* of the radiant and absorbent—the meat and the walls. It is necessary to use a table of logarithms for raising the numbers to the powers given in the above calculations.

TABLE 2 SHOWING LOSS OF HEAT BY RADIATION.

Showing the *ratio* of the loss of heat by radiation from a body suspended in an enclosed space at different temperatures, both of the body and the walls. From Dulong and Petit.

Excess of temperature of the body above that of the walls in degrees.		Temperature of the walls in Fahrenheit and Centigrade degrees.																
		-40	-31	-22	-13	-4	5	14	23	32	41	50	59	68	77	86	95	104
		-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40
Fahr.	Cent.	Ratio of heat emitted or absorbed by the body or the walls.																
9	5	·718	·743	·775	·805	·837	·869	·903	·938	·975	1·013	1·053	1·094	1·137	1·183	1·228	1·276	1·326
18	10	·731	·760	·790	·821	·853	·886	·921	·957	·994	1·033	1·073	1·113	1·159	1·204	1·251	1·300	1·351
27	15	·746	·775	·806	·837	·870	·904	·939	·978	1·014	1·053	1·095	1·137	1·182	1·229	1·276	1·326	1·379
36	20	·761	·790	·822	·854	·887	·922	·958	·995	1·034	1·074	1·116	1·160	1·205	1·252	1·301	1·352	1·406
45	25	·776	·807	·838	·871	·905	·940	·977	1·015	1·055	1·097	1·139	1·184	1·230	1·278	1·328	1·380	1·435
54	30	·791	·823	·854	·887	·922	·958	·996	1·034	1·075	1·117	1·161	1·206	1·253	1·302	1·353	1·406	1·462
63	35	·807	·839	·872	·906	·941	·978	1·016	1·056	1·097	1·140	1·185	1·231	1·279	1·329	1·381	1·436	1·493
72	40	·824	·856	·890	·925	·961	·998	1·037	1·078	1·120	1·164	1·209	1·256	1·306	1·357	1·411	1·465	1·523
81	45	·841	·873	·907	·943	·980	1·018	1·058	1·099	1·142	1·187	1·233	1·281	1·332	1·384	1·438	1·494	1·554
90	50	·858	·892	·926	·963	1·003	1·039	1·080	1·122	1·166	1·212	1·259	1·308	1·359	1·413	1·468	1·525	1·585
99	55	·875	·910	·945	·982	1·021	1·061	1·102	1·145	1·190	1·237	1·284	1·335	1·387	1·441	1·497	1·556	1·618
108	60	·894	·929	·965	1·004	1·042	1·083	1·125	1·169	1·214	1·262	1·311	1·363	1·416	1·471	1·529	1·589	1·652
117	65	·912	·948	·985	1·024	1·063	1·105	1·148	1·193	1·240	1·288	1·338	1·391	1·444	1·501	1·560	1·621	1·686
126	70	·931	·968	1·006	1·045	1·086	1·128	1·172	1·218	1·266	1·315	1·367	1·420	1·475	1·533	1·593	1·656	1·721
135	75	·952	·989	1·029	1·068	1·109	1·153	1·198	1·242	1·293	1·343	1·396	1·450	1·507	1·566	1·628	1·692	1·758

Loss of Heat by Contact of Air.—"The loss of heat by contact of cold air is independent of the nature of the surface, so that cast iron, stone, wood, etc., etc., lose the same amount of heat under the same conditions of temperature, but the *form* of the body affects the results considerably, so that a plane, a sphere, and a cylinder will lose different amounts of heat per square foot in the same time."—Box, op. cit.

"It has been already shown that a body placed in vacuo and surrounded by an enclosure at a lower temperature than itself will gradually lose heat. If the body be surrounded not by vacuum, but by a gas, it will lose heat more rapidly than in vacuo, and the difference between its velocity of cooling in the two cases is due to the presence of the gas. Thus the whole velocity of cooling of a body in air or gas is due partly to radiation and partly to gas."—Stewart, op. cit.

"The velocity of cooling due to the sole contact of a gas is entirely independent of the nature of the body. Thus, as far as gas or air is concerned, a silvered thermometer will cool just as rapidly as a blackened one; but as far as radiation is concerned it will cool less rapidly than the blackened one.

"The velocity of cooling due solely to the contact of a gas is proportional to the excess of temperature raised to the power of 1.233. From this law also we see the difference between cooling in vacuo and the cooling due to a gas.

"In vacuo the effect for the same excess of temperature of the thermometer above the enclosure varies also with the temperature of the enclosure, whereas in the case of a gas it depends only on the excess of temperature. The cooling power of a given gas and for a given excess of temperature depends *not on the density* but on the *pressure* of the gas."—Stewart, op. cit.

"For the small differences of temperature (between the air and the body) we may admit that the loss of heat is simply proportional to that difference; but with great differences of temperature, Dulong has shown that the loss of heat increases in a much higher ratio than that difference, so that, for instance, when a body is 450° F. above the temperature of the air, the loss per degree is double the loss with a small difference of say 20° F."—Box, op. cit.

"The researches of Dulong show that the loss by contact of cold air is independent of the absolute temperature of the heated body, differing in this respect from radiant heat. He also found that the heat lost increases more rapidly than the simple ratio of the excess of temperature. Putting his formula with the constants given by Pictet into such a form as to give a *ratio* for the different temperatures we have the rule

$$R''' = \frac{\cdot 552 \times t^{1\cdot 233}}{t}$$

in which t = the difference of temperature of the body and the air in contact with it in degrees centigrade, and R''' = the *ratio* of the loss of heat with that difference.

"It should be observed that the departures from the simple law are much less than with radiant heat. The following table gives the ratio of the loss of heat by contact of cold air.

Table 3.—Showing the Ratio of Heat emitted or absorbed by contact of cold air with given differences of temperature.

Difference of Temperature of the Air and the Body in Contact		Ratio of Heat.	Difference of Temperature of the Air and the Body in Contact		Ratio of Heat.
F.	C.		F.	C.	
3.6	2	.650	99	55	1.403
5.4	3	.713	108	60	1.433
7.2	4	.762	117	65	1.460
9	5	.803	126	70	1.486
18	10	.944	135	75	1.510
27	15	1.037	144	80	1.533
36	20	1.111	153	85	1.554
45	25	1.169	162	90	1.575
54	30	1.220	171	95	1.595
63	35	1.264	180	100	1.615
72	40	1.305	189	105	1.632
81	45	1.340	198	110	1.650
90	50	1.372			

"Let P (plate II., fig. 2) be a cube of any *material*, having its surfaces, SS, one foot square maintained at 60°, and let the walls, WW, also have the temperature of 60° F., while the air in contact with SS is at 59°. There will be no loss of heat in this case from SS by radiation because WW and SS are at the same temperature, nor will there be any loss by conduction as P has the same temperature all through, but heat will be given out to the cold air, and experiment has shown that the amount for 1° as in our case is ·5945 unit per square foot per hour, for a plane one foot high, but it will not be the same for any other height as will now be shown.

"If we investigate the loss of heat by a vertical plane we shall be able to see the reason for the variation in the loss of heat by contact with cold air. A vertical plane one foot high is found by experiment to lose ·5945 unit per square foot per hour when heated 1° above the air in contact with it, but a high plane or wall loses *less* per square foot for the following reason:—Let fig. 3 (plate II.) represent a plane 4 feet high, heated to 60° while the air in contact with it is at 59°. The air in immediate contact with the wall being heated by it, is expanded thereby, becomes lighter than the surrounding air and ascends in a constant current as shown by the arrows."—Box, op. cit.

"Now for the first or lowest foot, the air is at 59° to begin with, but departs from it at a slightly increased temperature, so that there is *less* than 1° difference when it comes in contact with the second foot, and for that reason it receives less heat from it than it did from the lowest foot, and so throughout each successive foot receives the air at progressively increased temperature, and imparts less and less heat to it."

"The loss by a vertical plane is given by the rule—

$$A = ·361 \times (·233 \div \sqrt{H.})$$

in which A = the loss in units per square foot per hour for 1° difference in temperature, and H = the height of the plane or wall in feet."—Box, op. cit.

The following table has been calculated by this rule:—

Table 4.—Showing the value of A, or the loss of heat by contact of cold air from a vertical plane of any material, with 1° difference in temperature between the body and the air in contact with it. In units per square foot per hour.

VALUE OF **A** FOR VERTICAL PLANES.

Height of the Plane in Feet.	Loss of Heat in Units per Square Foot for 1° difference.	Height of the Plane in Feet.	Loss of Heat in Units per Square Foot for 1° difference.
1	·5945	9	·4386
2	·5820	10	·4347
3	·4962	11	·4313
4	·4780	12	·4283
5	·4655	20	·4133
6	·4561	30	·4037
7	·4491	40	·3980
8	·4434	60	·3924

"This explanation of the reason why a high wall does not lose the same amount as a low one, will give some idea of the cause of the difference between bodies having the same area but differing in form. Those bodies lose most heat whose form allows the most free access and circulation of the air which carries off their heat."—Box, op. cit.

For a horizontal cylinder the rule becomes—

$$A = \cdot 421 + (\cdot 307 \div r),$$

in which A = the loss in units per square foot of surface per hour, for a difference in temperature between the body and the air of 1°, and r = the radius of the cylinder in inches.

Table 5.—Showing the loss of heat from contact of air with horizontal cylinders per square foot per hour for a difference of 1° Fah.:—

VALUE OF **A** FOR HORIZONTAL CYLINDERS.

Diameter in Inches.	Loss of Heat in Units per Square Foot for 1° difference, Horizontal Cylinder.	Diameter in Inches.	Loss of Heat in Units per Square Foot for 1° difference, Horizontal Cylinder.
2	·7280	13	·4682
3	·6256	14	·4648
4	·5745	15	·4619
5	·5440	16	·4594
6	·5230	17	·4571
7	·5087	18	·4551
8	·4978	24	·4466
9	·4892	36	·4381
10	·4824	48	·4338
12	·4722		

For a vertical cylinder the rule becomes—

$$A = \cdot 726 + \left\{ \frac{\cdot 2163}{\sqrt{r.}} \right\} \times (2 \cdot 43 + \left\{ \frac{5 \cdot 49}{\sqrt{h.}} \right\} \times \cdot 2044$$

in which A and r have the same signification as before, and h = the height in inches.

The following table is calculated from this rule:—

Table 6.—Showing the loss of heat by contact of cold air by vertical cylinders in units per square foot per hour for a difference of 1° Fah.

VALUE OF **A** FOR VERTICAL CYLINDERS.

Diameter in Inches.	Loss of Heat in Units per Square Foot for 1° difference.				
	Height of the Cylinder in Inches.				
	12	24	36	48	60
2	·7733	·6835	·6474	·6199	·6046
4	·7213	·6378	·6038	·5789	·5639
8	·6846	·6051	·5731	·5492	·5353
12	·6683	·5906	·5594	·5355	·5224
18	·6550	·5790	·5483	·5255	·5121
24	·6471	·5718	·5416	·5188	·5058
36	·6377	·5638	·5338	·5117	·4985

In removing the heat from a body by means of cold air, care must be taken to obtain a free circulation, otherwise the temperature of the air will rise until it approaches that of the body, its passage along the surface of the heated body will be rendered slower, and, consequently, the removal of the heat greatly checked. To attain the best results it would seem to be necessary to admit the cold air *below* the radiant, and to withdraw the air that has passed over the hot surface from above. By this arrangement no obstacle is placed in the way of a free circulation.

Let fig. 4, plate II., represent a case where the surface, S, of a heated body, say, meat, loses heat simultaneously by radiation and contact of cold air. Here W W, the walls, are at a temperature of 15·04 F., the air is at 14° F. and the body, P, at a temperature of 80° F.

Here the surface, S, is radiating heat to the walls, W, at a *ratio* by Table 2, for a difference of 65° (80° — 15°) of 1·02. The value of R, or the radiative power of meat, being taken at, say, 1·25 (by Table 1) units per square foot per hour, the heat emitted at the *commencement* of the operation will be at the rate of $1{\cdot}25 \times 65 \times 1{\cdot}02 = 84{\cdot}15$ units per square foot per hour.

The loss of heat by contact of cold air will be (by Table 3), for a difference of 66° F., at the *ratio* of 1·278; and the value of A being (by Table 4), for a plane 1 foot high, ·5945 unit per square foot per hour, we have $\cdot 5945 \times 66 \times 1{\cdot}278 = 50{\cdot}145$ units as the rate of loss of heat by contact of cold air per square foot per hour at the commencement of the operation. The total loss, therefore, from radiation and contact of cold air per square foot per hour will be at the rate of $84{\cdot}15 + 50{\cdot}145 = 134{\cdot}295$ units at the commencement of the operation; but as the quantity of heat is limited to what is contained in the meat, the amount emitted falls off from the very commencement of the cooling.

Loss of Heat by Conduction.—"Let P (fig. 5, plate II.) be a plate of building stone 1 foot square, 1 inch thick, having its surface, S, maintained at 60°, and let the walls, W W W, and the air in contact with S, be at 60° also, while the surface, S′, is at 59°, there will be no loss by radiation and contact of air, because both the walls, W W W, and the air are at the same temperature as S, but a certain amount of heat will be transmitted from S to S′; and for stone 1 inch thick the loss will be 13·7 units per square foot per hour for 1° difference. This amount will vary greatly with the nature of the material, we will call it C, and its value is given in the following table. The amount of heat lost, also, varies directly as the difference of the temperature of the two surfaces, S and S′, and inversely as the thickness, and hence we have the rule—

$$C' = C \times d \div E.$$

When C' = the loss by conduction in units per square foot per hour, C = the conducting power of the material, E the thickness of the plate in inches, and d the difference of temperature between S and S′. Thus, a stone wall, 20 inches thick, having one surface at 70° and the other at 40°, taking the value of C at 13·7, will transmit $13{\cdot}7 \times (70-40) \div 20 = 20{\cdot}55$ units per square foot per hour."—Box, op. cit.

Table 7.—Showing the value of C or the conducting powers of the materials, being the quantity of heat, in units, transmitted per square foot per hour by a plate 1 inch thick, the two surfaces differing in temperature 1°. From the experiment by Peclêt.*

	Value of C.
Copper	515.
Iron	233.
Zinc	225.
Lead	113.
Stone, fine calcareous	16·7
Stone, ordinary...	13·68
Glass	6·6
Baked Clay, brickwork	4·83
Plaster, ordinary	3·86
Fir Wood, perpendicular to the fibre	·748
Fir Wood, parallel to the fibre	1·37
Gutta Percha	1·38
Indiarubber	1·37
Brickdust, sifted	1·33
Coke, pulverised	1·29
Cork	1·15
Chalk, in powder	·869
Charcoal of Wool, in powder	·636
Straw, chopped...	·563
Coal, small sifted	·547
Wood ashes	·531
Mahogany dust	·523
Canvas of Hemp, new	·418
Calico, new	·402
Writing Paper, white	·346
Cotton Wool and Sheep Wool...	·323
Hair, felt	·293
Blotting Paper, grey	·274
Meat	5·3
Oil	14·5
Water, at 60°	5·316
Do., mean between 95° and 32°	6·6
Ice, at 32°	2·64

Having thus shown the value of the three elements, R, A, and C, we will now endeavour to apply them to a building artificially cooled for the purpose of refrigeration.

* Mr. Coleman (of Messrs. Bell, Coleman and Co.), as the result of a series of experiments instituted by him, has ascertained the following

In the case of refrigerating rooms, as ordinarily constructed, we shall have to bear in mind, as a leading principle, that what is to be aimed at is *the exclusion of heat from the exterior*. A mental picture should be formed of a *porous building*, through the walls of which, in spite of all we can do, a constant stream of heat is flowing. Unless the heat is removed as fast as it streams in, the temperature of the interior would rise until it became the same as that of the ground upon which the building rested and that of the surrounding air. The rate at which the stream of heat will flow into the enclosure depends, of course, entirely upon the material and manner of construction.

Adopting the notation and formula as given by Box in his work on heat, the calculations as given in Appendix B. will show the method as applied to a refrigerating room for the purpose of ascertaining the value of *U*, or the quantity of heat flowing through the walls. It will be seen that this can be done in various ways, and as the *leakage* depends entirely upon the materials used and the manner of construction, its detection and measurement is one of the most important items to be ascertained by the engineer in charge. As far as can be learned, no work has hitherto been published on this subject. Particular attention should be given to it, not only as a protection against loss of engine power and time, but also for the purpose of ascertaining the best materials to use, and the most economical method to be adopted in the construction of the refrigerating chambers.

THE PROCESS OF DECOMPOSITION.

In order to realize fully what are the conditions necessary for preserving a perishable organic substance, we should be able to form a clear conception of what the process of

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values for the conducting power (C) of various materials used in insulating buildings. The value of C of charcoal being taken at ·531

Silicate Cotton	·382
Hair Felt	·446
Cotton Wool	·462
She p's Wool	·515
Infusorial Earth	·515
Sawdust	·620
Wood and Air Space	1·062

decomposition really is. The knowledge of this process, usually termed "fermentation" or "putrefaction," as the case may be, has been developed very greatly of late years, and by none to such an extent as by the eminent French scientist, Pasteur, whose discoveries in this particular branch have excited the admiration of all. As the subject is too great to be dealt with in a paper like this, we can only glance briefly at its leading features.

It is now a well ascertained fact that the decomposition of organic substances is due to the action of minute living organisms, which, penetrating the tissues, increase at an enormous rate, at the expense of the substances composing the body in which they have effected a lodgment. Experiment shows that they are to be found almost everywhere in the atmosphere, being most numerous in a moist warm air and proportionately scarce in dry cold regions. Heat and moisture are necessary to their existence, although a temperature of 160° F. destroys them. At and below 32° F. they become dormant, and their vigour increases as the temperature rises, until, in the case of the germs producing acid fermentation (*vibrios*), they arrive at their maximum state of energy, at a temperature of from 60° to 80° F., and, in the case of the germs producing putrid fermentation (*bacteria*), at a temperature of 95° to 105° F., at which point putrid decomposition is most rapidly effected. Confining our attention to the changes which occur in the case of animal tissues being subjected to the action of the vibrios and bacteria, we find, as stated by Schutzenberger, that—

"Organic matter of animal origin left in contact with air undergoes progressive and complex transformations, known under the name of putrefaction and of slow combustion, whose effect is to transform them into principles more and more simple by means of decomposition and oxidation, so that in the end the carbon is restored to the air in the form of dioxide, the hydrogen under the form of water, and the nitrogen either as free nitrogen or ammonia. M. Pasteur has distinguished among the complicated facts of putrid fermentation two orders of distinct phenomena, although each is connected with the reactions set up by living organisms. The first includes the putrefaction which takes place without the assistance of oxygen in the air, which is caused by the presence of vibrios; the second, slow combustion, is due to the bacteria, mucors and mucidines, which possess the remarkable property of exciting the oxidation of a great number of organic principles, such as sugars, alcohols, organic acids, albumenoids, nitrogenous matter, etc., at the expense of the oxygen of the air.

"After having proved by careful experiments that spontaneous slow combustion of animal or vegetable substances depends necessarily on the development of organisms in the interior or on the surfaces of the substances which are in process of decomposition, and that without organisms there is neither combustion nor absorption of oxygen, M. Pasteur traces the following picture of putrid decomposition in contact with air:—

"'Even the most easily decomposed animal matter, as, for instance, blood or urine, may be preserved for an indefinite length of time in air which has been calcined or deprived of its germs; under these conditions the absorption of oxygen is but trifling and putrefaction does not take place, and at the same time no infusoria are produced.

"'If, on the contrary, this same substance remains exposed to the ordinary air, it is oxidised, putrefies, and infusoria are developed. It is commonly known that putrefaction takes a certain time to declare itself—a period varying according to the circumstances of temperature, of the neutral, acid, or alkaline character of the liquid. Under favourable circumstances, twenty-four hours are required before the phenomenon begins to manifest itself by external signs. During the first period, an internal movement takes place in the liquid, the effect of which is to withdraw entirely the oxygen of the air which is in solution, and to substitute for it carbondioxide gas. The total disappearance of the oxygen, when the medium is neutral or slightly alkaline, is generally due to the development of the smallest kinds of infusoria, especially the *Monas crepusculum* and the *Bacterium termo*. A very slight troubling then takes place, because these little beings pass about in all directions. If the vessel containing the putrescible liquid has a large opening to the air, the bacteria perish only in the liquid mass, after the removal of the oxygen, while they continue, on the contrary, to propagate *ad infinitum* on the surface, because it is in contact with the air. There they cause a thin film to form, which goes on thickening by degrees until it falls to the bottom of the vessel, then another forms, and so on continually. This film, to which different mucors and mucidines are attached, prevents the solution of oxygen gas in the liquid, and consequently allows the development of vibrios. With respect to these latter organisms, the vessel is as if it were closed against the introduction of air.

"'The putrescible liquid thus gives rise to two very distinct kinds of chemical action, which have reference to the two sorts of organisms which are nourished in it. On one hand, the vibrios, living by the co-operation of the oxygen of the air, set up in the interior of the liquid acts of fermentation, that is to say, they transform the nitrogenous matter into more simple but still complex products. The bacteria (or the mucors), on the other hand, consume these same products, and bring them to the state of the most simple, ordinary combinations—water, ammonia, and carbondioxide.'

"Summing up the experiments made by Pasteur, it may be said that putrefaction is always accompanied by the presence, the development, and the multiplication of infinitely small organised living beings; and, on the other hand, whenever we place the organic substances under such conditions that the germs or organisms are entirely excluded, or *rendered dormant*, decomposition can be indefinitely postponed, even in those products which are most liable to it.

"Two orders of phenomena are to be distinguished in putrefaction; some are produced under the influence of those organisms which can exist and increase without the presence of oxygen; others, on the contrary, require oxygen, and can only develop in its presence, the resulting products being of a simpler composition than the substances from which they are derived. It is, in fact, a gradual degrading of the highly complex organic compounds, and results in their being finally separated into the original simple elements from which all organic substances are built up, namely, oxygen, hydrogen, and nitrogen."—Schutzenberger, op. cit.

THE PROCESS OF REFRIGERATION.

The process of refrigeration is thus shown to be the removal of a certain quantity of the molecular motion of the substance operated upon. As already seen, radiation and contact of cold air are the two channels through which the heat will pass away, conduction, in our case, being only available in bringing the interior heat to the surface.

In order that radiation may exercise the fullest effect, it is necessary that the bodies to be chilled shall radiate their heat to the walls or to some solid body, and *not to themselves*. If by reason of their number and contiguity, straight lines drawn from any one of the bodies shall fall upon any of the others, the heat that would radiate from this body in the direction of the straight lines will not be removed but exchanged, and consequently radiation will be suppressed in proportion as the space is occupied by radiants or recipients, that is, by bodies which are emitting heat, or bodies that are absorbing it.

The following diagram (plate II., fig 6) will illustrate the effect produced in a chilling room as ordinarily constructed, and will show that the radiation from a large number of the bodies is suppressed, except to the floor or ceiling, thereby cutting off a considerable proportion of radiative power and causing the heat of the bodies to be retained longer.

In the chilling of meat this is a most serious drawback, as it gives time for the germs of decomposition to get fairly established, and much mischief is caused by the delay.

In the case of B, which is one of a number of hot bodies placed in an enclosure at a low temperature for the purpose of being cooled, we see that rays of radiant heat from any part of its surface outside the line, C D, will strike the walls, W W, and be by them absorbed.

The walls, W W, being at a very much lower temperature than B do not radiate back to the body the same amount of heat as received, and the temperature of B falls in consequence. But in the case of rays proceeding from B towards A, the radiation from A and the surrounding bodies being nearly the same as that of B, there is *an exchange* of heat, but not much loss, and consequently B's temperature is only slightly lowered by radiation from the surface facing A. The bodies A, and those in similar positions, being surrounded by others at nearly the same temperature, do not lose heat in the direction of the walls, and their rate of cooling will be much slower, as far as radiation is concerned, than B.

It should also be particularly noted that, as air is transparent to radiant heat (see pg. 11), a very small proportion of the radiation proceeding from the bodies to be cooled will be directly absorbed by it, and of this small proportion by far the larger quantity is undoubtedly absorbed by the vapour suspended therein. The radiation is received by the walls and is by them given up by *contact* to the cold air. Not only is the heat radiating from the bodies to be cooled (the radiants) carried away by the air in contact with the surface of the walls, but there is also the flow of heat which comes through the walls themselves. What this may amount to depends entirely upon the insulation of the building. In fact the whole stream of heat from the walls, as well as that from the radiant, is transferred by contact to the cold air.

As in practice the results previously calculated are not always obtained, the cause must be looked for in the want of opportunity for the meat to give up the contained heat. Fig 6 shows at once how deficient is the wall area, the only place where the heat radiating from the meat can lodge, and also that the majority of the quarters hanging in the room are unable to part with their radiant heat to any extent (and how much more must this be the case when double the number of quarters are hung in the same space.) Consequently, the object to be aimed at is to *increase* the area of surface available for receiving the radiation, and which will also at the same time increase that to be brought in contact with the cold air.

Proceeding now to increase the area of the recipient or absorbent, that is, to give a larger proportion of surface of some solid material which shall act as a medium of exchange between the radiant and the cold air, care must be taken that we do not interfere with the free circulation of the cold air.

The following diagram (fig. 7, plate II.) will illustrate one method of doing this, and its simplicity and cheapness are points in favour of its adoption.

The radiants are hung in the same manner as before, and between each is suspended a calico or canvas screen, or, in fact, a screen of any material. As the value of A, or the loss by contact of cold air is the same from the surface of all materials, a canvas screen will answer as well as anything else, and it has the advantage of portability. Hung, say, by hooks, at a distance of 12 inches from the ceiling, and reaching to within 18 inches of the floor, it would present a surface to each quarter, and every ray of radiant heat would be intercepted by it. Taking the case of a room $36 \times 9 \times 7$ feet, with 60 quarters hanging therein, and allowing free circulation all round, the additional surface exposed to the emission of heat from the radiants would be ($34 \times 3 \times 4{\cdot}5$ feet) + ($20 \times 2{\cdot}6 \times 4{\cdot}5$) = 684 feet of screen, *both sides* of which, or 1,368 sup. feet, would be available both for radiation and also for contact of cold air.

As the area of the walls, floor, and ceiling is 1,278 sup. feet, by giving an additional 1,368 feet we double the area available for radiation. On the plan of fig. 6, the area of surface available for contact of cold air is that of the walls, floor, and ceiling $=1,278$ feet, together with the surfaces of the 60 quarters, making $1,278+780=2,058$ sup. feet. By the addition of the screens a total of $2,058+1,368=3,426$ sup. feet, becomes available as against 2,058 without the screens, and when it is remembered that it is by contact of cold air only that the heat is removed (radiation acting as an intermediate factor in the case), it is evident that we shall have increased our power very largely.

The heated air should be removed from the room in the usual manner, that is, from the top, and, contrary to the plan generally adopted in the refrigerating rooms as at present constructed, the cold air should be admitted at the bottom. There are several good reasons why this should be done, which it is well to enumerate. First is the fact illustrated in fig. 3, plate II., where it is shown that the loss by contact of cold air depends upon the circulation of the cold air *upwards*, and that if the current is intercepted or stopped the air is not able to get away with the heat. 2nd. Warm air being less dense than cold air, its natural place is above, and anything retarding its rise interferes with the natural and complete circulation. 3rd. That air containing moisture is lighter than dry air at the same temperature, and as it is very important to remove the moisture from the surface of the meat, *especially at the commencement of the operation*, it is most desirable to have, on this account, a distinct upward circulation.

The only reason given for admitting the cold air at the top is that the temperature is rendered thereby alike at the top and bottom of the room. It cannot increase the circulation, as it is impossible to get the warm air out of the room quicker than the cold air is put in. Why it should be thought advisable to have an equal temperature above and below is not apparent. The object we have in view is the *removal of the heat*, and not to keep the temperature of the room even, and this will be best accomplished by producing a steady flow of cold air through the room, which shall, by coming into contact with the walls, screens, and surfaces of the meat, take up and remove the heat we wish to carry away. Nature tells us in unmistakable language which are the relative positions of the warm and cold air, and we should endeavour to give the fullest opportunity for the working of these natural laws, and not try to turn upside-down, as it were, the operation by which she works.

The best sign we can have of regular and successful work would be the rise in temperature of the departing air. As it can only be warmed by the heat emitted from the meat, leaving out of the question for the moment the flow of heat through the walls, we have, in the rise of temperature, a proof of work done ; and the warmer the air, the more rapidly will the radiants be cooled. With a view of developing the transfer of heat to the cold air to the fullest extent, the plan, as illustrated in plate II., fig. 8, has been adopted. The freshly killed meat is placed in the compartment A, which is of a size large enough to hold one day's slaughtering. The chamber B being made of any size to suit requirements, and the engine power is, of course, adapted to it. Taking a case where the size of B is 60 × 36 × 7 feet, and the engine circulates 37,500 feet of air per hour at an initial temperature of 50°, A is 36 × 9 × 7 feet, and is capable of holding about 60 quarters of beef, in three rows of twenty each. In consequence of the whole 37,500 cubic feet of air passing through this small chamber, containing 2,268 cubic feet, the renewal is very rapid, and from the position of the inlets and outlets, D and E, the current flows over the meat in the direction that ensures the greatest amount of contact. Screens are hung between the quarters, as in fig. 7, thus giving the meat every opportunity to part with its heat both by radiation and by contact of cold air. As the chamber A is required for more meat, that already hanging is transferred in the usual manner to B, and day by day it is worked down to the cold end of the room, where, when fully frozen, it is stacked for shipment. It was thought that owing to the position of the inlet, there would be great inequality in the temperature of the rooms, but on trial it was found that the tendency to equalisation was so great that practically the thermometer showed the same registration wherever it was put. This may be accounted for by the fact that at any place in the enclosure where the temperature was higher, the air would become more expanded and lighter and consequently a more rapid circulation upward would take place at that particular point until equilibrium was established; and experiment showed that this was very quickly done. As an additional aid to producing the greatest amount of contact of the cold air with the surface of the meat and screens, it might be advisable to produce an artificial circulation by means of fans or blowers. Probably the best results would be obtained with fans placed on the walls near the floor and worked from the outside. If two sides of the room were fitted with these, an additional contact of the cold air would be produced which would be of great advantage. It would imitate to some extent a breeze of wind, and it is in everyone's experience that any warm body placed in a draught is cooled more rapidly than is the case when the only current is that produced by the warmed air ascending along the surfaces of the hot body.*

It should also be borne clearly in mind that what we are endeavouring to do, is to exclude the germs, which are the cause of putrefaction, from the meat we are operating upon. As these germs are present everywhere, and only require a temperature ranging from, say, 35° F. to 95° (being most active at the latter point, and practically dormant at the

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* As it may often be desirable to promote a vigorous circulation in rooms in which meat is hanging, a careful examination of the effect produced by the action of the fan becomes necessary in order that the actual amount of energy which is expended in driving it may be calculated, and from that the equivalent amount of heat ascertained which is of necessity dissipated in the air contained in, or passing through the room.

From the laws governing falling bodies, and also from actual experiment, the exact amount of power required to drive a fan through which a certain amount of air at a given velocity is passing, is readily ascertained. In his "Treatise on Heat," Mr. Box gives the amount of air passing per minute through fans of various dimensions, and running at different speeds, and also the amount of energy in foot-pounds expended in doing the work. As 772 foot-pounds is the dynamical equivalent of one unit of heat, the amount of heat evolved as the result of the motion of the fan is thus deducible.

Taking the work of a 50,000 feet refrigerating machine, running at a speed of 65 revolutions per minute, the amount of air actually passed through the compressors will be about 40,000 per hour, and if a fan be used to circulate this air, of the dimensions and running at the speeds as given former), to increase and multiply to an extent almost incredible, our efforts should be directed to lowering the temperature of the meat to 35° as speedily as possible.

It may be taken for granted that whatever the result as to the toughness or condition, &c., of the meat may be, if such be caused by too rapid freezing, if the germs of

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in the following table, the units of heat dissipated and the rise in the temperature of the air contained in the room will be found in columns 4 and 5.

Table showing the heat gained in one hour by 40,000 feet of air contained in an enclosed space, and passing through a circulating fan of different dimensions and running at the speeds given. In degrees Fah.; also the energy required to drive the fan in foot-pounds per minute, and in units per hour.

Diameter of the fan in feet.	Size of Exit opening in feet.			Actual Velocity of the Air, 5 feet per second.					Actual Velocity of the Air, 10 feet per second.				
	Width.	Length.	Area.	Revolutions of the fan per minute.	Cubic feet of air passing through the fan per minute	Foot-pounds per minute.	Units per hour.	Rise in the temperature of the air in degrees.	Revolutions of the fan per minute.	Cubic feet of air passing through the fan per minute	Foot-pounds per minute.	Units per hour.	Rise in the temperature of the air in degrees.
3	1·5	1·8	2·7	73	810	96	7·50	·01	146	1620	384	30	·04
4	2·0	2·4	4·8	54	1440	171	13·25	·02	108	2880	684	53	·07
5	2·5	3·0	7·5	44	2250	267	20·75	·03	88	4500	1068	83	·11
6	3·0	3·6	10·8	37	3240	385	30	·04	74	6480	1540	120	·16
7	3·5	4·2	14·7	32	4410	524	40·75	·06	64	8820	2096	163	·22
8	4·0	4·8	19·2	28	5760	685	53·25	·07	56	11520	2740	213	·30
9	4·5	5·4	24·3	25	7290	867	67·50	·09	50	14580	3468	270	·37
10	5·0	6·0	30·0	22	9000	1070	83·25	·11	44	18000	4280	333	·46
12	6·0	7·2	43·2	18	12960	1540	120	·16	36	25920	6160	480	·66
15	7.5	9·0	67·5	15	20250	2403	187	·26	30	40500	9610	747	1·03
				(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)

As it is evident that the heat into which the motion and friction of any machine is finally resolved, cannot exceed the amount (expressed in power) required to drive it, we are at once enabled to calculate very exactly the actual heating of the air that will take place in any enclosed space under the conditions above described. As many trials have been made with blowers or fans for the purpose of producing rapid circulation, and the result being an immediate and very considerable rise in the temperature of the air, the gain of heat was attributed entirely to compression by the fan, and to the friction of the machine. If the heat evolved by the fan is limited absolutely by the amount of power required to drive it, and if the heating of the air is found to exceed the amount due to this cause, the excess must be due to one of two other causes :—Either it must come through the walls, or it must be removed from the meat hanging in the room. If the insulation is perfect the conclusion that the excess of heat is derived from the bodies hanging in the room is obvious, and as the quantity of heat contained in them is limited, the quicker it is removed the sooner will their temperature be reduced to the required point.

decomposition once get fairly hold of the meat, the injury done is irremediable, and the result a total failure.

It is also not to be denied that, if the temperature is sufficiently low and dry enough to render the germs inactive, or if the atmosphere be free from them, it would be better to hang the meat in the open air.

The only advantage to be gained by this method is that of cheapness, as the condition of the meat would in all respects be the same as if cooled down in a chamber. If it is desirable to allow the meat to hang, for the purpose of becoming more tender, this can be done just as well after it has been thawed out for consumption as before, provided, as is now the case, storage rooms are arranged for the purpose of thawing the meat, under proper conditions as to dryness, &c.

When it becomes a question for decision whether the meat shall hang for a certain time in the open air, at a comparatively high temperature, say 80° or 90° F., with a large percentage of vapour present, as is usually the case in this latitude near the coast—a condition which, of all possible, is the one most fitted for the growth and development of the germs of decomposition—or whether it should be put at once into the freezing room, under proper conditions as to circulation of air, &c., there can be little doubt as to the best course to pursue. The extra cost of coal and time being but small items as against the risk of failure and loss by decomposition.

It is laid down as an axiom, by those practically interested in the work of refrigeration, that fresh-killed meat should on no account be put into a room, the temperature of which is considerably below freezing point. The reasons given are as follow:—1st. That the *noxious gases* should be allowed to escape into the open air. 2nd. That by too rapid refrigeration the *animal heat is frozen in*, thereby causing the meat to go bad. 3rd. That there is a certain amount of shrinkage in the meat when exposed to intense cold, which causes it to leave the bone, thereby giving an unsightly appearance of the quarters.

Taking these objections *seriatim*, and commencing with the *noxious gases*, it is stated that the body of an animal killed for food contains a quantity of noxious gas or vapour, which it is necessary to remove before putting the carcass into the freezing room.

A gas, to be noxious, in the sense in which it appears to be used by the supporters of this theory, must be the result of the decomposition of animal matter. As the function of the blood is to remove all decomposing and effete matter from the system, if noxious gases exist in the body of the animal we wish to kill, we may be quite sure that it is in such a state of disease, with active decomposition going on in the tissues, as to render its flesh totally unfit for human food. If the flesh, muscles, &c., contain noxious gases—and we cannot suppose the interior tissues of the body to be free, and the vapours or gases to be retained in the large cavities only—it is a certainty that no amount of hanging in the open air, or anywhere else, will remove them.

So long as life remains in an animal, and the blood circulates, the products of decomposition are removed as fast as made, and it is only in a time of sickness that these products are produced at a greater rate than they can be taken away. If the animal is in good health, the time when the body is *most free* from decomposing matter will be at the moment of its death. From that moment the products of decomposition cease to be removed, and if the temperature be kept up, it is only a question of a longer or shorter time, according to circumstances, before they become perceptible to the senses.

We may therefore dismiss the idea that any noxious gases exist in the tissues of an animal fit for human food. That there is a certain characteristic odour emitted from the viscera when the animal is opened, we all know, but this is not a noxious gas, and disappears with the removal of the offal.

Freezing in the Animal Heat.—To those who hold the "Dynamical Theory" of heat to be the correct one, the idea of freezing in heat seems to be an absolute contradiction, and contrary to all reason. It would appear to be much the same as filling, say, a box, the sides of which were composed of wire gauze, with air, and putting it into a vacuum, expecting the gauze to retain the air contained in the interior of the box. A clear conception of the nature of heat shows at once that such a thing as freezing in heat is impossible, and in order to realise it, we will endeavour to follow the action of the process of cooling as it takes place in such a substance as meat. In the first place let us look at the composition of meat. The table 1 (Appendix A) gives the constituents of an average fat bullock and sheep, and from it we find that *21* parts are bone, *3·6* parts mineral matter, *11·9* parts nitrogenous substances, *27·5* parts fatty matter, and *36* parts water. Above a temperature of, say, 95°, the 27·5 parts of fatty matter are in a more or less liquid state, but as we are not concerned with a temperature of 95°, but with one of 32°, we have only to consider the 36 parts of water as being in the fluid state. All the other 64 parts being then solid, their power of conduction remains unaltered, either above or below 32° Fah.

By turning to table 7 (page 23), which shows the very feeble conducting power of water when prevented from circulating, we are led to believe that it would act in a similar manner if locked up in an infinite number of small cells having walls of a feebly-conducting substance, and that in the case of meat, in which the watery constituents form portions of the contents of cells, the conduction of heat will not exceed that due to the water in the condition above named.

Inasmuch as water is the only part of the meat that would be *altered in condition* by the abstraction of heat, any difference in the conducting power of meat frozen and unfrozen would be due to the different conducting power of water and ice. According to MM. Despretz and Newman, the conducting power of ice and water stand in the proportion of ·0057 to ·0117 respectively, as compared with copper at 1·108, or in the proportion of 1 : 2 nearly, so that whatever the conducting power of meat may be at any temperature above freezing, the conductivity, when the temperature is reduced below 32° Fah., will be reduced, *so far as the effect due to the water only* is concerned, in the proportion of 2 : 1. The 64 per cent. of solid substance is not affected in its conducting power by the fact of the thermometer showing a temperature of over or under 32° Fah., as it is solid in both cases.

The specific heat of ice being ·489 as compared with water at 1·00, when the water contained in meat is frozen, the amount of heat to be abstracted from it to bring the temperature down any given number of degrees, is less than one-half of what it would be if in the liquid state. This will operate, so far, favourably, and will, to this extent, neutralise the reduced conducting power of ice, so that, taking into consideration the comparatively small portion of water, it seems probable that there will be little, if any, difference in the time required to reduce the temperature of any given weight of meat the same number of degrees above or below the freezing point of water.

If too rapid chilling had the effect of freezing in the animal heat, the thinner portions of a carcass, say the fore-quarters, flanks, etc., should, according to this argument, show the result in a much more marked manner than the thick hind-quarters, and consequently be more liable to taint. I would put this question to any practical refrigerator:—Which portion of a carcass suffers most from this supposed freezing in of the heat? In my experience, and I believe in that of every person who has had anything to do with this matter, it is *invariably the centre of the thick part where the taint occurs.* In other words, the germs which cause decomposition have only been able to get fairly to work in those parts which are thick enough to retain the heat sufficiently long. If the temperature of these parts had also been brought down as quickly as the external surfaces, it stands to reason that the germs would have been rendered inoperative, and the meat would have been in the same condition all through.

Further, it is also stated that by closing the pores of the meat by rapid chilling, the same effect is produced, namely, "the freezing in of the heat." Now any action that tends to bring the particles of a body closer together would, apparently, not retard but rather increase the flow of heat by conduction. This can be illustrated in many ways; for example, when rock crystal is in the solid state it conducts heat freely, but when crushed up into powder, so that the particles are more widely separated, the conduction is extremely feeble. Also, when a non-conducting substance, such as a woollen cloth, is wrapped very tightly round a heated body it is found that more heat escapes than if it were loosely enveloped with the same material. It has been previously shown that the loss of heat by conduction depends upon the *conducting power of the substance, the difference in temperature between one side of the body and the other* and the *thickness of the body itself*, the flow of heat being inversely as the thickness. This is well illustrated in our case by the slowness with which the thick hind-quarters of beef part with their heat in comparison with the thinner fore-quarters. While on this subject it should be mentioned that, when once the meat is frozen through to the bone, the temperature falls much more rapidly than it did previously, which corroborates the statement as to the conducting power of ice, and shows that it was not the outer coating of ice that prevented the meat from freezing inside, but the *comparatively large amount of latent heat of liquefaction of the water* contained in the meat which delayed the operation. The previous calculation shows the enormous amount of latent heat to be removed from the meat at 32°, being considerably more than one-half of the total, or 388 out of 686 parts.

No indication of this work is given by the thermometer, which remains steadily at 32° until it is completed, and to those who are unacquainted with the fact, it might seem that something was not working properly, and measures taken to remedy what to them seemed a fault, and which would seriously interfere with the successful completion of the refrigeration.

If we examine the table of Radiation (No. 2), which shows the increased rapidity with which a body loses heat, as the *difference* between its temperature and that of the walls of the enclosure increases, also the table of the Loss by Contact of Cold Air (No. 3), which illustrates the increased rapidity with which a body gives up its heat as the *difference* between its own temperature and that of the cold air increases, and also remember the diminished conducting power as the thickness of the body increases, we shall no longer doubt that instead of "freezing in" the heat and retaining it by "closing the pores," the very reverse is the case. What has really happened when meat goes bad while hanging in the freezing room, is want of opportunity to radiate to some cold body other than itself, and a feeble and impeded circulation of cold air to take away the heat by contact with its surfaces. Given these two methods of removing heat in their full capability, and there can be no doubt as to the result. In Russia and Canada, where the winter supply of meat is killed at the commencement of the cold season, radiation and contact of cold air are the only methods made use of, and one never hears of the meat being bad, and for the simple reason that these methods of cooling are available to the fullest, whereas in the majority of freezing rooms, as at present constructed, both the radiative power and the contact of cold air are obstructed to a very great and unnecessary extent. Another weak point in the system generally adopted at the present time is that of keeping the meat too long exposed at a comparatively high temperature, say 70° to 80° Fah., whereby its surface is subjected to the attack of the germs. It is a common occurrence for the animals to be killed at seven o'clock in the morning and to remain exposed in the open air, at a high temperature, until four o'clock the next morning. It must surely be self-evident that the progress of decomposition is advanced by this 21 hours; and when the carcases are put into the freezing room, this work is *not undone*, but only arrested. It is impossible to restore the meat to its original state by putting it into a cold atmosphere. The germs are simply rendered dormant, and their work of destruction recommences, when the meat is thawed and raised in temperature again, *at the point where they left off*. This fact will explain the reason why meat, apparently sound when frozen, on being thawed out has proved to be partially decomposed. The work of decomposition had advanced so far, previous to the action of the germs being arrested by the cold, that, although the putrefaction was not perceptible to the organs of smell or taste, it was still there and a very short time only was required to bring it to that point at which the whole became tainted.

Shrinking of the Meat from the Bone.—As this is very likely to occur if the quarter is placed in a very low temperature immediately after death, the remedy must be looked for in not cutting the carcass into quarters, if possible, until it has hung for some time in the first room. As it is a small matter in comparison with others, and at most involving a little extra trouble, there does not seem to be any ground for anxiety, and measures can be easily taken to overcome the difficulty.

As circumstances must have occurred to give rise to the opinion relative to "Noxious Gases" and "The Freezing in of Animal Heat," it will be interesting to endeavour to ascertain what would be the condition under which such phenomena could most readily take place.

As noxious gases are the result of decomposition, then, if any are evolved, the tissues of the meat must have commenced to decompose. If this decomposition set in while the animal was alive, it was clearly in a state unfit for human food. If, on the other hand, the gases are evolved after death, then, also, must decomposition have commenced, and as this can only occur while the meat is above a certain temperature, it is evident that cooling has been delayed too long.

In the case where noxious gases have been evolved, the cooling process must have been delayed to such an extent that the *exterior portions* of the meat have retained their heat sufficiently long for active decomposition to have taken place, and, consequently, it would be hopeless to expect the interior portions to be sound, the meat being bad throughout. In the case where the "freezing in of the animal heat" has occurred, the process of cooling has been so far retarded that the interior portions only have retained their heat sufficiently long for the germs to make a sensible impression, and it is probable that the whole body of the meat would be in a more or less critical state, the exterior portion being on the verge of unsoundness, so that a warm, humid atmosphere, at the time of thawing, would speedily make the whole unfit for food.

Taking the extreme case in which noxious gases have been evolved while the meat was hanging in a room, the temperature of which was very low, and through which a large quantity of cold air was passing, what would be the requisite condition to produce such a result?

1st. We should require the meat to be so placed that little or no radiation could take place, and no heat be lost by that means.

2nd. We should have to restrict, as far as possible, the current of cold air from passing over the surfaces of the meat. The best way to accomplish this would be to hang the meat as far out of the line between the inlet and outlet as possible, knowing that air will take the shortest course from inlet to outlet, especially where the circulation is a forced one. Architects who have to deal with the ventilation of buildings experience great difficulty in causing air to distribute itself in an enclosed space, the currents being always *direct* from inlet to outlet, particularly when artificial means are used to force them.

3rd. We should also have to baffle, as much as possible, the ascending currents of air that were passing over the heated surfaces of the meat, not only to prevent the heat being abstracted from the meat, but also to retain the moisture on the surfaces as long as possible, moisture being a condition most favourable to the development of the germs.

Knowing the transparency of dry air to radiant heat, we should not require to take account of the air that was not in *actual contact* with the meat surfaces, as it is not warmed by the radiant heat passing through it.

How far are these conditions fulfilled in freezing-rooms as ordinarily constructed?

1st. We often see the meat hung in a compact mass, with no surfaces exposed to radiation, except those facing the walls, and which form but a small proportion of the total area.

2nd. The cold air is admitted at the top of a narrow room, and drawn off at the opposite side. The direction of the current is *mainly* across the top of the room, the density of the cold air, of course, causing a certain amount of descent, which so far is favourable to the chilling process, and especially to the meat hung on the cold side of the room. The ascending currents which flow along the surface of the meat are met by the descending cold currents, and to some extent neutralised, thereby causing an even temperature at the top and bottom of the room, but interfering greatly with the regular flow of air.

3rd. The flow of heated air upwards towards the outlets being baffled by the descending cold currents, and the air being incapable of being heated by radiation, there is no absorption, and very little heating by contact. We thus have the apparent anomaly of an intensely cold air, and bodies of meat retaining their heat long enough for decomposition to set in. To those unacquainted with the properties of air and radiant heat, such a state of affairs would seem impossible, and all sorts of theories are invented to account for what is a perfectly natural phenomenon, if properly understood.

In conclusion, as an example of the serious loss that can arise through the want of accurate information, I would draw your attention to the construction of the Brisbane Freezing Rooms at present under erection. Here we find brick walls, with a space filled with cow hair, and a cement floor. Referring to the table (No. 7) of the conducting powers of the different substances used in buildings, and calculating the flow of heat through the walls, it will be found that the loss under the same conditions as those given in the previous calculations would be 2.03 units per square foot per hour, and through the floor 4·13 units per square foot per hour, as compared with 0.85 units through the ceiling, which is composed of wood and cow-hair and sawdust insulation. Had the insulation been made of wood and charcoal, inside a 9 inch brick wall, and the floor covered with lead or zinc, to prevent damp, a very considerable saving of engine power would result.

APPENDICES.

THE following appendices contain calculations and tables which will be found useful in tracing the process of refrigeration, as applied to meat, &c. :—

APPENDIX A.

No. 1.—Of the composition of meat.

,, 2.—Of the latent heat of aqueous vapour.

,, 3.—Of the weight, volume, thermal equivalent, &c., of dry air.

,, 4.—Of the vapour removed from atmospheric air, and of the heat given out by compression.

,, 5.—Of the heat produced by compression of dry air.

,, 6.—Of the cold produced by expansion of dry air.

APPENDIX B.

Calculation showing the work done in a freezing chamber :—

1st.—In removing the heat flowing through the walls.

2nd.—In reducing the temperature of meat hanging therein.

APPENDIX C.

Calculation illustrating the reduced cooling power of meat as the thickness increases, and also the increased time required for the refrigeration of a thick hindquarter as compared with the ribs and flanks.

APPENDIX A.

TABLE 1.—Showing the composition of the following animals when fat. From "The Stock-feeders Manual," by Mr. Cameron. Also the specific heat of the carcasses at ordinary temperature, and when frozen.

Animal.	Bone.		Mineral Matter.		Nitrogenous Substances.		Fat.		Water.	Specific Heat at Ordinary Temperatures.	Specific Heat when Frozen.
	Parts in 100	Specific Heat ·260	Parts in 100	Specific Heat, ·200	Parts in 100	Specific Heat, ·240	Parts in 100	Specific Heat, ·290	Parts in 100		
Ox.	21	5·46	3·65	0·72	11·9	2·85	27·5	8·25	36·	·533	·348
Ox, hindquarter.	17	4·42	3·78	0·75	12·50	3·00	28·9	8·67	37·8	·546	·353
Sheep.	20?	5·2	2·76	0·55	9·20	2·21	36·3	10·90	31·8	·507	·351
Lamb.	20?	3·9	3·08	0·61	9·26	2·22	31·36	9·01	41·3	·574	·559
Pig.	20?	5·2	1·12	0·22	8·5	2·04	39·6	11·88	30·9	·502	·345

The actual weights of the flesh, fat, mineral substances, etc., are taken from an average of many experiments made by Lawes and Gilbert. The weight of bone in the ox is taken from an average of five animals of 820 lbs. each, dressed weight. The ten forequarters averaged 202 lbs., less 51 lbs. bone. The ten hindquarters, 209 lbs., less 36 lbs. bone.

The specific heat of fat, ·290, and its latent heat 40°, are taken from actual experiment. The weight of bone in the sheep, lamb, and pig, estimated at 20 per cent. The specific heat of the bone, mineral matters and nitrogenous substances, ascertained approximately from other sources.

APPENDIX A.

TABLE 2.—Showing the amount of heat given out to a cubic foot of air by the condensation of the vapour contained therein, if fully saturated, at the different temperatures given. Also the heat given out by the condensation of 1 grain of vapour per cubic foot of air at the same temperatures. In degrees Fah.

Temperature.		If Condensed by Pressure.		If cooled to 32° and condensed by expansion.		If cooled to 32° condensed and frozen by expansion.	
Fah.	Cent.	Total amount of heat given out to the air.	Rise due to the condensation of 1 grain of vapour.	Total amount of heat given out to the air.	Rise due to the condensation and cooling to 32° of 1 grain of vapour.	Total amount of heat given out to the air.	Rise due to the condensation cooling to 32° and freezing of 1 grain of vapour.
32	0	17°	8·15°	0°	8·15°	19·5°	9·20°
41	5	24	8·24	7	8·30	28	9·39
50	10	33	8·34	17	8·48	39	9·58
59	15	47	8·43	30	8·65	54	9·77
68	20	64	8·53	47	8·83	75	9·95
77	25	86	8·62	70	9·00	101	10·14
86	30	115	8·72	101	9·17	136	10·33
95	35	152	8·81	140	9·34	180	10·52
104	40	199	8·90	191	9·51	238	10·72

APPENDIX B.

Calculation of the work done in a freezing chamber of the following dimensions, with walls 24 inches thick, composed of wood and charcoal:—

	Wall Area.
External dimension, $64 \times 40 \times 11$ ft., =	7,408 sup. ft. area.
Internal dimension, $60 \times 36 \times 7$ ft., =	5,664 sup. ft. area.

Mean of external and internal superficial area of the walls, 6,536 sup. feet.

Internal area, $60 \times 36 \times 7$ ft., = 15,120 cub. feet.

Temperature of external air = 77° F.
Temperature of internal air = 14° F.

Adopting Box's rule and notation—

T = Temperature of external air.
T′ = Temperature of internal air.
t = Temperature of external walls.
t′ = Temperature of internal walls.
R = The radiant power of the materials.
A = The loss by contact of cold air.
C = Conducting power of the materials.
Q = R + A.
U = Units per square foot per hour.
E = Thickness of walls in inches.

Or,

$$T = 77^\circ \quad C = \cdot 55 \quad E = 24.$$
$$T' = 14^\circ \quad Q = 1\cdot 315.$$

R for 63° diff. per table 2 = $\cdot 736 \times 1\cdot 016 = \cdot 747$.
A for 63° diff. per table 3 and 7ft. high per table 4 } = $\cdot 449 \times 1\cdot 264 = \cdot 568$.

To find the temperature of the external surface of the wall = t.

$$t = \frac{\{Q \times [E \times A \times T) + (C \times T']\} + \{A \times C \times T\}}{\{C \times [2 \times A) + R]\} + \{E \times A \times Q\}}$$

$$= \frac{\{1\cdot 315 \times [24 \times \cdot 568 \times 77) + (\cdot 55 \times 14]\} + \{568 \times \cdot 55 \times 77\}}{\{\cdot 55 \times [2 \times \cdot 568) + \cdot 747]\} + \{24 \times \cdot 568 \times 1\cdot 315\}}$$

$$= \underline{74\cdot 54} = t.$$

To find the temperature of the internal surface of the wall = t′.

$$t' = \frac{(C \times t) + (Q \times E \times T')}{C + (Q \times E).}$$

$$= \frac{(\cdot 55 \times 74 \cdot 54) + (1 \cdot 315 \times 24 \times 14)}{\cdot 55 + (1 \cdot 315 \times 24).}$$

$$= \underline{15 \cdot 04} = t'.$$

To find the amount of heat transmitted through the walls—

1st.—Calculated from the temperature of the walls.

$$\frac{C \times (t - t')}{E} = \frac{\cdot 55 \times 74 \cdot 54 - 15 \cdot 04}{24} = \underline{1 \cdot 366}$$

2nd.—Calculated from the temperature of the surface of the internal wall and the temperature of the internal air.

$$Q \times (t' - T') = 1 \cdot 315 \times (15 \cdot 04 - 14) = \underline{1.366.}$$

3rd.—Calculated from the temperature of the external surface of the walls and the temperature of the internal air.

$$\frac{Q \times (t - T')}{1 + \frac{(Q \times E)}{C}} = \frac{1 \cdot 315 \times 74 \cdot 54 - 14}{1 + \frac{1 \cdot 315 \times 24}{\cdot 55}} = \underline{1 \cdot 366}$$

4th.—Calculated from the temperature of the external and internal air only. This is, perhaps, the most useful rule.

$$\frac{(A \times C \times Q) \times (T - T')}{\{C \times [2 \times A) + R]\} + \{E \times A \times Q\}}$$

$$= \frac{(\cdot 568 \times \cdot 55 \times 1 \cdot 315) \times (77 - 14)}{\{\cdot 55 \times [2 \times \cdot 568) + \cdot 747]\} + \{24 \times \cdot 568 \times 1 \cdot 315\}}$$

$$= 1 \cdot 366.$$

Having found the flow of heat per square foot per hour into a chamber of the above dimensions, it is an easy matter to ascertain the total amount of heat gained by leakage. As there is a considerable difference between the superficial area of the external and internal surfaces of the walls, it will be necessary to take the *mean area*. This is as stated above—6,536 sup. feet. Multiplying 6,536 by 1·366, we have the total flow of heat through the wall into the chamber of

8,928 units per hour.

Having ascertained this, the rise in the temperature of the cold air due to the influx of heat through the walls can also be ascertained. Taking the average quantity of cold air entering the machine per hour at 50,000 cubic feet, and allowing 75 per cent. for effective work, which seems to be the most that can be expected, according to the experiments of Professor Colladon, of Geneva, the net amount of air entering the expansion cylinder, at a temperature of, say, 50° Fah., will be

37,500 feet.

As this 37,500 feet removes 8,928 units of heat per hour from the chamber, each cubic foot carries away 8,928 ÷ 37,500 =

·238 unit.

Turning to table 3, in column 9, under the head of *units*, will be found the weight of water thermally equal to 1 cubic foot of air. At a temperature of 50° F. this amounts to 0·0185 lb., consequently ·238 ÷ ·0185 = 12·9 will be the number of degrees Fah. that 1 cubic foot of air will be heated in absorbing ·238 unit of heat. As the temperature of the room is 14° F. when heated by the flow through the walls, it will be correspondingly lower on entrance, or at 1° Fah.

Testing it another way, and taking the air as issuing from the expansion cylinder at a temperature of 1° Fah., by table 3 the weight of air at 1° is 604 grains per cubic foot, as compared with 545 grains at a temperature of 50°, consequently, 37,500 cubic feet at 50° F. will only occupy a space of 33,800 cubic feet at 1° (604 : 545 :: 37,500). This 33,800 cubic feet of cold air absorbs 8,928 units of heat in neutralising the flow of air through the walls, and is consequently heated in a proportionate degree, or by 8,928 ÷ 33,800 = ·264 unit per foot.

By column 9, in table 3, 1 cubic foot of air at 1° F. is thermally equal to 0·0205 lb. of water, and therefore when heated by ·264 unit, its temperature would rise ·264÷·0205 =12·9 degrees Fah., thus showing that if the insulation is practically equal to the amount as given in Box's tables, the loss of 13° at a temperature of 1° Fah. will compensate the flow through the walls.

239	115	698	388	1·4217	397	0·0567	17·633	0·0134	74·273
248	120	707	393	1·4400	392	0·0560	17·857	0·0133	75·234
257	125	716	398	1·4583	387	0·0553	18·046	0·0131	76·017
266	130	725	403	1·4767	382	0·0547	18·325	0·0130	77·190
275	135	734	408	1·4950	378	0·0540	18·519	0·0128	78·007
284	140	743	413	1·5133	373	0·0533	18·766	0·0126	79·052
293	145	752	418	1·5317	369	0·0527	18·971	0·0125	79·910
302	150	761	423	1·5500	364	0·0520	19·231	0·0123	81·007
311	155	770	428	1·5683	360	0·0514	19·445	0·0122	81·907
329	165	788	438	1·6049	352	0·0503	19·888	0·0120	83·773
347	175	806	448	1·6415	344	0·0491	20·350	0·0117	85·717
365	185	824	458	1·6783	336	0·0480	20·834	0·0114	87·760
383	195	842	468	1·7149	329	0·0470	21·276	0·0112	89·626
401	205	860	478	1·7515	323	0·0461	21·673	0·0109	91·290
419	215	878	488	1·7883	316	0·0451	22·152	0·0107	93·313
437	225	896	498	1·8249	310	0·0443	22·581	0·0105	95·117
455	235	914	508	1·8615	304	0·0434	23·103	0·0103	97·315
473	245	932	518	1·8983	298	0·0427	23·491	0·0101	98·950
491	255	950	528	1·9349	291	0·0417	23·508	0·0099	99·022
509	265	968	538	1·9715	286	0·0410	24·476	0·0097	103·10
527	275	986	548	2·0083	281	0·0401	24·913	0·0095	104·94
545	285	1004	558	2·0494	276	0·0394	25·363	0·0094	106·83
563	295	1022	568	2·0815	271	0·0389	25·831	0·0092	108·81
581	305	1040	578	2·1183	267	0·0381	26·218	0·0090	110·44
599	315	1058	588	2·1549	262	0·0374	26·718	0·0088	112·54
617	325	1076	598	2·1915	258	0·0367	27·132	0·0087	114·29
635	335	1094	608	2·2283	253	0·0361	27·670	0·0085	116·55

TABLE 3

Showing the volume, weight per cubic foot, and cubic feet per lb. of dry air at temperatures ranging from −238° to 635° Fahrenheit. Also a comparison of Fahrenheit and Centigrade Degrees with the absolute temperatures. Also the thermal equivalents of air and water per cubic foot and lb.

The barometrical pressure is taken at 29·922 inches, or 760 mm. metrical; and the volume of air at 32° = 1·000000.

Ordinary Temperatures.		Absolute Temperatures.		Volume of 1 cubic foot Air at 32° = 1·0000	Weight per Cubic Foot.		Cubic feet per lb.	Units.	
Fahr.	Cent.	Fahr.	Cent.		Grains.	Lbs.		Lbs. of water thermally equivalent to 1 cubic foot of air.	Feet of air thermally equivalent to 1 lb. of water.
−238	−150	221	123	·4499	1255	0·1794	5·577	0·0426	23·495
−220	−145	230	128	·4683	1206	0·1723	5·804	0·0409	24·450
−220	−140	239	133	·4866	1161	0·1659	6·029	0·0394	25·395
−211	−135	248	138	·5050	1119	0·1596	6·255	0·0379	26·351
−202	−130	257	143	·5233	1079	0·1541	6·487	0·0366	27·328
−193	−125	266	148	·5416	1043	0·1490	6·711	0·0354	28·271
−184	−120	275	153	·5600	1009	0·1441	7·000	0·0343	29·486
−175	−115	284	158	·5783	977	0·1395	7·165	0·0332	30·181
−166	−110	293	163	·5966	947	0·1353	7·392	0·0321	31·137
−157	−105	302	168	·6150	919	0·1313	7·617	0·0312	32·086
−148	−100	311	173	·6333	892	0·1274	7·848	0·0302	33·057
−139	−95	320	178	·6517	867	0·1239	8·074	0·0294	34·011
−130	−90	329	183	·6700	843	0·1204	8·313	0·0286	35·020
−121	−85	338	188	·6883	821	0·1173	8·526	0·0279	35·916
−112	−80	347	193	·7066	800	0·1143	8·750	0·0271	36·858
−103	−75	356	198	·7250	780	0·1114	8·974	0·0264	37·804
−94	−70	365	203	·7433	760	0·1088	9·198	0·0258	38·748
−85	−65	374	208	·7616	742	0·1061	9·447	0·0252	39·794
−76	−60	383	213	·7800	725	0·1036	9·655	0·0246	40·672
−67	−55	392	218	·7983	708	0·1011	9·887	0·0240	41·648
−58	−50	401	223	·8166	692	0·0988	10·116	0·0235	42·611
−49	−45	410	228	·8350	677	0·0967	10·340	0·0230	43·566
−40	−40	419	233	·8533	662	0·0946	10·574	0·0225	44·542
−31	−35	428	238	·8717	648	0·0926	10·903	0·0219	45·504
−22	−30	437	243	·8900	635	0·0907	11·024	0·0215	46·436
−13	−25	446	248	·9083	622	0·0888	11·254	0·0210	47·406
−4	−20	455	253	·9266	610	0·0871	11·475	0·0207	48·340
5	−15	464	258	·9450	598	0·0854	11·706	0·0203	49·309
14	−10	473	263	·9633	586	0·0837	11·946	0·0199	50·319
23	−5	482	268	·9816	576	0·0821	12·153	0·0195	51·192
32	0	490·86	272·7	1·0000	565·1	0·0807	12·390	0·0192	52·190
41	5	500	278	1·0183	554·9	0·0793	12·636	0·0188	53·225
50	10	509	283	1·0366	545·1	0·0779	12·844	0·0185	54·105
59	15	518	288	1·0550	536·0	0·0766	13·060	0·0182	55·013
68	20	527	293	1·0733	526·6	0·0752	13·307	0·0178	56·059
77	25	536	298	1·0916	517·6	0·0739	13·500	0·0175	57·034
86	30	545	303	1·1100	509·1	0·0727	13·752	0·0173	57·930
95	35	554	308	1·1283	500·8	0·0715	13·972	0·0170	58·856
104	40	563	313	1·1466	492·8	0·0704	14·228	0·0167	59·933
113	45	572	318	1·1650	485	0·0693	14·433	0·0165	60·797
122	50	581	323	1·1833	478	0·0683	14·644	0·0162	61·688
131	55	590	328	1·2016	471	0·0674	14·862	0·0160	62·604
140	60	599	333	1·2200	463	0·0661	15·119	0·0158	63·686
149	65	608	338	1·2383	456	0·0651	15·351	0·0155	64·664
158	70	617	343	1·2566	451	0·0643	15·522	0·0153	65·381
167	75	626	348	1·2750	443	0·0633	15·802	0·0150	66·561
176	80	635	353	1·2933	437	0·0624	16·018	0·0148	67·475
185	85	644	358	1·3116	431	0·0616	16·242	0·0146	68·414
194	90	653	363	1·3300	425	0·0607	16·471	0·0144	69·381
203	95	662	368	1·3483	419	0·0598	16·707	0·0142	70·374
212	100	671	373	1·3667	414	0·0591	16·908	0·0140	71·223
221	105	680	378	1·3850	408	0·0582	17·156	0·0138	72·271
230	110	689	383	1·4033	403	0·0574	17·370	0·0136	73·108
239	115	698	388	1·4217	397	0·0567	17·633	0·0134	74·273
248	120	707	393	1·4400	392	0·0560	17·857	0·0133	75·234
257	125	716	398	1·4583	387	0·0553	18·046	0·0131	76·017
266	130	725	403	1·4767	382	0·0547	18·325	0·0130	77·190
275	135	734	408	1·4950	378	0·0540	18·519	0·0128	78·007
284	140	743	413	1·5133	373	0·0533	18·766	0·0126	79·052
293	145	752	418	1·5317	369	0·0527	18·971	0·0125	79·910
302	150	761	423	1·5500	364	0·0520	19·231	0·0123	81·007
311	155	770	428	1·5683	360	0·0514	19·445	0·0122	81·907
329	165	788	438	1·6049	352	0·0503	19·888	0·0120	83·773
347	175	806	448	1·6415	344	0·0491	20·350	0·0117	85·717
365	185	824	458	1·6783	336	0·0480	20·834	0·0114	87·760
383	195	842	468	1·7149	329	0·0470	21·276	0·0112	89·626
401	205	860	478	1·7515	323	0·0461	21·673	0·0109	91·290
419	215	878	488	1·7883	316	0·0451	22·152	0·0107	93·313
437	225	896	498	1·8249	310	0·0443	22·581	0·0105	95·117
455	235	914	508	1·8615	304	0·0434	23·103	0·0103	97·315
473	245	932	518	1·8983	298	0·0427	23·491	0·0101	98·950
491	255	950	528	1·9349	291	0·0417	23·508	0·0099	99·022
509	265	968	538	1·9715	286	0·0410	24·476	0·0097	103·10
527	275	986	548	2·0083	281	0·0401	24·913	0·0095	104·94
545	285	1004	558	2·0494	276	0·0394	25·363	0·0094	106·83
563	295	1022	568	2·0815	271	0·0389	25·831	0·0092	108·81
581	305	1040	578	2·1183	267	0·0381	26·218	0·0090	110·44
599	315	1058	588	2·1549	262	0·0374	26·718	0·0088	112·54
617	325	1076	598	2·1915	258	0·0367	27·132	0·0087	114·29
635	335	1094	608	2·2283	253	0·0361	27·670	0·0085	116·55

foot.

s per cubic foot.

	47·	50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5
	61·7	64·7	67·6	70·5	73·5	76·4	79·4	82·3	85·3	88·2
	4·2	4·4	4·6	4.8	5·	5·2	5·4	5·6	5·8	6·
…0	·238	·227	·217	·208	·200	·192	·185	·179	·171	·167
	1·63	1·65	1·67	1·69	1·71	1·73	1·74	1·75	1·77	1·78
	13	13	13	14	14	14	14	14	14	14
	·50	·48	·46	·44	·42	·40	·39	·38	·36	·35
	2·26	2·29	2·32	2.35	2·38	2·41	2·42	2·44	2·46	2·48

TABLE 4 (APPENDIX A).

Showing the heat produced by the condensation of vapour from a cubic foot of saturated air—

1. The amount of vapour condensed at the different pressures and temperatures given, in grains per cubic foot.
2. The rise in the temperature of the air due to the condensation of the vapour, in degrees Fah.
3. The amount of vapour remaining in the air after compression, in grains per cubic foot.

The barometrical pressure, 29·92 inches, or 14·7 lbs. per square inch. The weight of vapour in grains per cubic foot.

Pressure above atmosphere in lbs.				2·9	5·9	8·8	11·7	14·7	17·6	20·6	23·5	26·5	29·4	32·3	35·3	38·2	41·2	44·1	47·	50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5
Absolute pressure in lbs.				17·6	20·5	23·5	26·5	29·4	32·3	35·3	38·2	41·2	44·1	47·	50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5	76·4	79·4	82·3	85·3	88·2
Absolute atmospheres				1·2	1·4	1·6	1·8	2·	2·2	2·4	2·6	2·8	3·	3·2	3·4	3·6	3·8	4·	4·2	4·4	4·6	4·8	5·	5·2	5·4	5·6	5·8	6·
Ratio of less to the greater				·833	·714	·625	·556	·500	·454	·417	·385	·357	·333	·312	·294	·278	·263	·250	·238	·227	·217	·208	·200	·192	·185	·179	·171	·167
Initial Temperature. Fah.	Initial Temperature. Cent.	Grains of vapour contained in 1 foot of saturated air.	Rise in temperature due to the total condensation of the vapour contained in the air.																									
32°	0°	2·13	17°	·37	·62	·83	·96	1·06	1·16	1·24	1·31	1·37	1·42	1·46	1·50	1·54	1·57	1·60	1·63	1·65	1·67	1·69	1·71	1·73	1·74	1·75	1·77	1·78
				3	5	6	8	8	9	10	10	11	11	11	12	12	12	13	13	13	13	14	14	14	14	14	14	14
				1·76	1·51	1·30	1·17	1·07	·97	·89	·82	·76	·71	·67	·63	·59	·56	·53	·50	·48	·46	·44	·42	·40	·39	·38	·36	·35
41°	5°	2·97	24°	·56	·85	1·12	1·32	1·48	1·62	1·73	1·82	1·91	1·98	2·04	2·09	2·14	2·18	2·23	2·26	2·29	2·32	2·35	2·38	2·41	2·42	2·44	2·46	2·48
				5	7	9	11	12	13	14	15	16	16	16	17	17	17	18	18	19	19	19	19	20	20	20	20	20
				2·41	2·12	1·85	1·65	1·49	1·35	1·24	1·15	1·06	·99	·93	·88	·83	·79	·74	·71	·68	·65	·62	·59	·56	·55	·53	·51	·49
50°	10°	4·10	33°	·69	1·17	1·44	1·82	2·05	2·23	2·39	2·52	2·63	2·73	2·82	2·89	2·96	3·02	3·08	3·12	3·17	3·20	3·24	3·28	3·32	3·34	3·37	3·40	3·42
				6	10	13	15	17	18	19	20	21	22	22	23	24	24	25	25	26	26	26	27	27	27	28	28	28
				3·41	2·93	2·56	2·28	2·05	1·87	1·71	1·58	1·47	1·37	1·28	1·21	1·14	1·08	1·02	·98	·93	·90	·86	·82	·78	·76	·73	·70	·68
59°	15°	5·57	47°	·93	1·59	2·07	2·45	2·78	3·04	3·24	3·42	3·58	3·71	3·83	3·93	4·01	4·10	4·18	4·24	4·30	4·36	4·41	4·45	4·50	4·54	4·58	4·61	4·64
				8	14	18	21	24	25	27	29	30	31	31	32	33	34	35	35	36	36	37	38	38	39	39	39	39
				4·64	3·98	3·5	3·12	2·79	2·53	2·33	2·15	1·99	1·86	1·74	1·64	1·56	1·47	1·39	1·33	1·27	1·21	1·16	1·12	1·07	1·03	·99	·96	·93
68°	20°	7·50	64°	1·25	2·15	2·81	3·33	3·75	4·10	4·37	4·61	4·81	5·0	5·16	5·30	5·42	5·53	5·63	5·72	5·80	5·87	5·94	6·0	6·07	6·11	6·16	6·20	6·25
				10	18	24	28	32	34	37	39	41	43	44	45	46	47	48	48	49	50	51	51	52	52	52	53	53
				6·25	5·35	4·69	4·17	3·75	3·40	3·13	2·89	2·69	2·50	2·34	2·20	2·08	1·97	1·87	1·78	1·70	1·63	1·56	1·50	1·43	1·39	1·34	1·30	1·25
77°	25°	9·98	86°	1·64	2·85	3·74	4·43	4·99	5·45	5·82	6·14	6·42	6·65	6·88	7·05	7·20	7·34	7·48	7·60	7·70	7·80	7·90	8·0	8·06	8·13	8·20	8·26	8·32
				14	24	32	38	43	46	49	52	55	57	59	61	62	64	65	65	66	67	68	69	70	70	71	71	72
				8·34	7·13	6·24	5·55	4·99	4·53	4·16	3·84	3·56	3·33	3·10	2·93	2·78	2·64	2·50	2·38	2·28	2·18	2·08	2·0	1·92	1·85	1·78	1·72	1·66
86°	30°	13·15	115°	2·15	3·80	4·95	5·87	6·57	7·18	7·67	8·08	8·45	8·77	9·05	9·29	9·50	9·70	9·86	10·02	10·16	10·30	10·42	10·52	10·62	10·71	10·81	10·90	10·96
				19	33	43	51	58	63	67	71	74	77	79	81	83	84	86	87	89	90	91	92	93	94	95	95	96
				10·9	9·35	8·2	7·28	6·58	5·97	5·48	5·07	4·70	4·38	4·10	3·86	3·65	3·45	3·29	3·13	2·99	2·85	2·73	2·63	2·53	2·44	2·34	2·25	2·19
95°	35°	17·16	152°	2·89	4·89	6·42	7·65	8·58	9·37	10·01	10·56	11·04	11·44	11·81	12·11	12·38	12·63	12·87	13·07	13·26	13·42	13·58	13·73	13·87	13·99	14·1	14·21	14·3
				25	43	57	67	76	82	89	94	98	101	104	107	109	112	114	115	117	118	120	122	123	124	125	126	127
				14·27	12·27	10·74	9·51	8·58	7·79	7·15	6·6	6·12	5·72	5·35	5·05	4·78	4·53	4·29	4·09	3·9	3·74	3·58	3·43	3·29	3·17	3·06	2·95	2·86
104°	40°	22·24	199°	3·72	6·36	8·43	9·87	11·12	12·13	12·96	13·67	14·29	14·83	15·3	15·9	16·05	16·38	16·68	16·95	17·2	17·41	17·61	17·79	17·96	18·17	18·32	18·45	18·53
				33	56	75	88	100	109	117	123	128	132	136	140	144	147	149	151	154	156	158	160	161	163	164	165	166
				18·52	15·88	13·81	12·37	11·12	10·11	9·28	8·57	7·95	7·41	6·94	6·54	6·19	5·86	5·56	5·29	5·04	4·83	4·63	4·45	4·28	4·07	3·92	3·79	3·71

pressures, in degrees Fah.
Fah.\

Pressu		50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5
Absolu	7	64·7	67·6	70·5	73·5	76·4	79·4	82·3	85·3	88·2
Absolu	2	4·4	4·6	4·8	5·	5·2	5·4	5·6	5·8	6·
Ratio	o	·651	·642	·635	·627	·620	·613	·607	·601	·595
	4	264	274	283	292	301	310	319	327	335
	3	13	13	14	14	14	14	14	14	14
	7	277	287	297	306	315	324	333	341	349

TABLE 5 (Appendix A.)

Of the Heat produced by the Compression of Air—

1. The rise in the temperature of dry air when compressed adiabatically at the following temperatures and pressures, in degrees Fah.
2. The heat given out by the condensation of the vapour contained in the air, if fully saturated, in degrees Fah.
3. The total rise in the temperature of the compressed air, in degrees Fah.
4. The resulting temperature by Fahrenheit's scale.

The barometrical pressure, 29·92 inches, or 14·7 lbs. per square inch

Pressure above the Atmosphere in lbs.		2·9	5·9	8·8	11·7	14·7	17·6	20·6	23·5	26·5	29·4	32·3	35·3	38·2	41·2	44·1	47·	50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5
Absolute pressure in lbs.		17·6	20·5	23·5	26·5	29·4	32·3	35·3	38·2	41·2	44·1	47	50	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5	76·4	79·4	82·3	85·3	88·2
Absolute Atmospheres		1·2	1·4	1·6	1·8	2·	2·2	2·4	2·6	2·8	3	3·2	3·4	3·6	3·8	4·	4·2	4·4	4·6	4·8	5	5·2	5·4	5·6	5·8	6·
Ratio of the less to the greater		·948	·907	·873	·843	·818	·796	·776	·758	·742	·727	·714	·701	·690	·679	·669	·660	·651	·642	·635	·627	·620	·613	·607	·601	·595
INITIAL TEMPERATURE.																										
Fahr	Cent																									
32°	0°	26	50	72	91	109	126	142	157	171	185	198	210	222	233	243	254	264	274	283	292	301	310	319	327	335
		3	4	5	6	8	9	10	10	11	11	11	12	12	13	13	13	13	13	14	14	14	14	14	14	14
		29	54	77	97	117	135	152	167	182	196	209	222	234	246	256	267	277	287	297	306	315	324	333	341	349
		61	86	109	129	149	167	184	199	214	228	241	254	266	278	288	299	309	319	329	338	347	356	365	373	381
41°	5°	27	51	74	93	111	128	145	160	174	187	201	214	225	237	248	258	268	279	288	298	307	316	325	333	341
		4	7	9	11	12	13	14	15	15	16	16	17	17	18	18	18	19	19	19	19	20	20	20	20	20
		31	58	83	104	123	141	159	175	189	203	217	231	242	255	266	276	287	298	307	317	327	336	345	353	361
		72	99	124	145	164	182	200	216	230	244	258	272	283	296	307	317	328	339	348	358	368	377	386	394	402
50°	10°	27	52	74	94	113	130	148	163	177	192	204	218	229	242	253	263	273	285	293	304	314	323	332	340	348
		5	9	12	14	17	18	19	20	21	22	23	24	24	24	25	25	26	26	26	27	27	27	28	28	28
		32	61	86	108	130	148	167	183	198	214	227	242	253	266	278	288	299	311	319	331	341	350	360	368	376
		82	111	136	158	180	198	217	233	248	264	277	292	303	316	328	338	349	361	369	381	391	400	410	418	426
59°	15°	28	52	75	96	115	133	150	166	180	195	207	221	233	246	257	268	278	290	298	309	319	328	337	346	354
		7	13	17	21	24	25	27	29	30	31	32	33	34	34	35	36	37	37	37	38	39	39	39	39	39
		35	65	92	117	139	158	177	195	210	226	239	254	267	280	292	304	315	327	335	347	358	367	376	385	393
		94	124	151	176	198	217	236	254	269	285	298	313	326	339	351	363	374	386	394	406	417	426	435	444	452
68°	20°	28	54	77	98	117	135	153	169	184	198	211	225	237	250	261	272	283	295	303	315	325	334	343	352	361
		11	18	24	28	32	34	37	39	41	43	44	45	46	47	48	48	49	50	50	51	51	52	52	53	53
		39	72	101	126	149	169	190	208	225	241	255	270	283	297	309	320	332	345	353	366	376	386	395	405	414
		[illegible]	[illegible]	[illegible]	164	217	237	258	276	293	309	323	338	351	365	377	388	400	413	421	434	444	454	463	473	482
77°	25°	29	55	78	100	119	137	155	172	187	202	216	229	241	253	265	278	289	300	310	321	331	340	349	357	366
		14	24	32	38	43	46	49	52	55	57	59	61	62	64	65	65	66	67	68	69	70	70	71	72	72
		43	79	110	138	162	183	204	224	242	259	275	290	303	317	320	343	355	367	378	390	401	410	420	429	438
		120	156	187	215	239	260	281	301	319	336	352	367	380	394	407	420	432	444	455	467	478	487	497	506	515
86°	30°	29	56	80	101	121	137	158	175	190	205	218	233	246	258	271	283	293	303	313	325	335	345	354	363	372
		19	32	43	51	57	63	67	71	74	77	79	81	83	84	86	87	89	90	91	92	93	94	95	95	96
		48	88	123	152	178	200	225	246	264	282	297	314	329	342	357	370	382	393	404	417	428	439	449	458	468
		134	174	209	238	264	286	311	332	350	368	383	400	415	428	443	456	468	479	490	503	514	525	535	544	554
95°	35°	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	237	250	263	275	287	298	310	320	331	341	351	360	369	378
		25	42	57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	109	112	114	115	117	118	120	122	123	124	125	126	127
		55	[illegible]	138	168	[illegible]	224	[illegible]	272	[illegible]	[illegible]	327	344	359	375	389	402	415	428	440	453	464	475	485	495	505
		150	[illegible]	233	[illegible]	[illegible]	[illegible]	345	[illegible]	[illegible]	[illegible]	422	[illegible]	454	470	484	497	510	523	535	548	559	570	580	590	600

d at the temperatures given.

	50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5
7	64·7	67·6	70·5	73·5	76·4	79·4	82·3	85·3	88·2
2	4·4	4·6	4·8	5·0	5·2	5·4	5·6	5·8	6.0
516	1·537	1·557	1·576	1·595	1·612	1·631	1·648	1·665	1·681
168	172	176	180	184	188	191	194	197	200
136	-140	-144	-148	-152	-156	-159	-162	-165	-168
3	3	3	2	2	2	2	2	2	2
133	-137	-141	-146	-150	-154	-157	-160	-163	-166
171	175	179	183	187	191	194	197	200	203
130	134	-138	-142	-146	-150	-153	-156	-159	-162

TABLE 6 (APPENDIX A).

Showing the fall in the temperature of dry air when expanded.

1. The fall in temperature of dry air when expanded adiabatically from the following pressures and at the temperatures given.
2. The temperature of the expanded air, in degrees Fah. (if fully estimated).
3. The gain of heat due to the condensation and freezing of the aqueous vapour, in degrees Fah.
4. The resulting temperature, in degrees Fah.

Pressure above atmosphere in lbs.		2·9	5·9	8·8	11·7	14·7	17·6	20·6	23·5	26·5	29·4	32·3	35·3	38·2	41·2	44·1	47·	50·	52·9	55·8	58·8	61·7	64·7	67·6	70·5	73·5
Absolute pressure in lbs. ...	...	17·6	20·5	23·5	26·5	29·4	32·3	35·3	38·2	41·2	44·1	47·	50·	52·9	55·9	58·8	61·7	64·7	67·6	70·5	73·5	76·4	79·4	82·3	85·3	88·2
Absolute atmospheres ...	...	1·2	1·4	1·6	1·8	2·0	2·2	2·4	2·6	2·8	3·0	3·2	3·4	3·6	3·8	4·0	4·2	4·4	4·6	4·8	5·0	5·2	5·4	5·6	5·8	6·0
Ratio of the greater to the less ...		1·054	1·102	1·146	1·186	1·222	1·257	1·289	1·319	1·348	1·375	1·401	1·426	1·450	1·473	1·495	1·516	1·537	1·557	1·576	1·595	1·612	1·631	1·648	1·665	1·681
Initial Temperature.																										
Fah.	Cent.																									
32°	0	25	44	63	77	90	101	111	119	127	134	141	147	153	158	163	168	172	176	180	184	188	191	194	197	200
		7	-12	-31	-45	-58	-69	-79	-87	-95	-102	-109	-115	-121	-126	-131	-136	-140	-144	-148	-152	-156	-159	-162	-165	-168
		15	13	11	10	8	8	7	6	5	5	5	4	4	4	3	3	3	3	2	2	2	2	2	2	2
		22	1	-20	-35	-50	-61	-72	-81	-90	-97	-104	-111	-117	-122	-128	-133	-137	-141	-146	-150	-154	-157	-160	-163	-166
41°	5°	25	46	64	78	91	103	113	122	130	137	144	150	156	161	166	171	175	179	183	187	191	194	197	200	203
		16	-5	-23	-37	-50	-62	-72	-81	-89	-96	-103	-109	-115	-120	-125	-130	134	-138	-142	-146	-150	-153	-156	-159	-162
		21	18	15	13	12	10	9	8	8	7	7	6	6	6	5	5	5	4	4	4	4	3	3	3	3
		37	13	-8	-24	-38	-52	-63	-73	-81	-89	-96	-103	-109	-114	-120	-125	-129	-134	-138	-142	-146	-150	-153	-156	-159
50°	10°	26	47	65	80	93	105	115	124	132	139	146	152	158	163	168	173	178	183	187	191	195	198	201	204	207
		24	3	-15	-30	-43	-55	-65	-74	-82	-89	-96	-102	-108	-113	-118	-123	-128	-133	-137	-141	-145	-148	-151	-154	-157
		31	26	21	19	16	14	13	12	11	10	9	9	8	7	7	6	6	6	5	5	5	4	4	4	4
		50	29	6	-11	-27	-41	-52	-62	-71	-79	-87	-93	-100	-106	-111	-117	-122	-127	-132	-136	-140	-144	-147	-150	-153
59°	15°	27	46	66	81	94	1[illegible]5	117	125	135	142	148	155	161	167	172	177	182	187	191	195	109	202	205	208	211
		32	13	-7	-22	-35	-46	-58	-66	-76	-83	-89	-96	-102	-108	-113	-118	-123	-128	-132	-136	-140	-143	-146	-149	-152
		41	36	30	26	22	20	18	17	15	13	12	12	11	11	10	9	9	8	8	7	7	7	6	6	6
		59	49	23	4	-13	-26	-40	-49	-61	-70	-77	-84	-91	-97	-103	-109	-114	-120	-124	-129	-133	-136	-140	-143	-146
68°	20°	27	48	67	83	96	108	119	128	136	144	152	158	164	170	175	180	185	189	193	197	201	205	209	212	215
		41	20	1	-15	-28	-40	-51	-60	-68	-76	-84	-90	-96	-102	-107	-112	-117	-121	-125	-129	-133	-137	-141	-144	-147
		52	48	42	36	32	28	25	22	20	18	17	16	15	14	13	13	12	11	10	9	9	8	8	8	7
		68	68	43	21	4	-12	-25	-38	-48	-58	-67	-74	-81	-88	-94	-99	-105	-110	-115	-120	-124	-129	-133	-136	-140
77°	25°	28	49	68	84	98	110	121	130	138	145	154	160	166	172	177	182	187	192	197	201	205	209	212	215	218
		49	28	9	-7	-21	-33	-44	-53	-61	-68	-77	-83	-89	-95	-100	-105	-110	-115	-120	-124	-128	-132	-135	-138	-141
		69	65	57	48	42	38	35	31	27	24	22	21	19	18	17	16	16	15	14	14	13	13	12	11	10
		77	77	66	41	21	5	-9	-22	-34	-44	-55	-62	-70	-77	83	-89	-94	-100	-106	-110	-115	-119	-123	-127	-131
86°	30	28	50	70	86	99	111	122	132	141	149	156	163	170	176	181	186	191	196	200	204	208	212	215	218	221
		58	36	16	0	-13	-25	-36	-46	-55	-63	-70	-77	-84	-90	-95	-100	-105	-110	-114	-118	-122	-126	-129	-132	-135
		91	75	74	65	57	50	45	41	38	35	32	30	28	26	25	23	21	19	18	17	17	16	16	15	15
		86	86	86	65	44	25	9	-5	-17	-28	-38	-47	-56	-64	-70	-77	-84	-91	-96	-101	-105	-110	-113	-117	-120
95°	35°	28	51	71	87	101	113	125	135	144	152	159	166	173	179	184	189	194	159	203	108	212	216	219	222	225
		67	44	24	8	-6	-18	-30	-40	-49	-57	-64	-71	-78	-84	-89	-94	-99	-104	-108	-113	-117	-121	-124	-127	-130
		121	100	97	84	75	66	59	54	49	45	41	39	37	34	32	30	28	26	25	24	23	22	22	21	20
		95	95	95	92	69	48	29	14	0	-12	-23	-32	-41	-50	-57	-64	-71	-78	-83	-89	-94	-99	-102	-106	-110

Calculating the amount of heat to be abstracted from a quantity of meat put into such a room, as illustrated by the last shipment sent from the Queensport Works—

Daily average quantity of meat put into the freezing rooms—42 quarters, weighing 180 lbs.	lbs. 7,560
Average temperature, 85°	
Specific heat ... ·533	

Heat required to be abstracted—

	Units.
1st. To bring down the temperature from 85° to 32° = 53°, 7,560 × 53 × ·533 ...	213,562
2nd. To freeze the water contained in 7,560 lbs., 2,721 lbs. × 142·6	388,014
3rd. To reduce 7,560 lbs. from 32° to zero, 7,560 × 32 × ·353 (·353 = specific heat of frozen meat	85,397
	686,974

Or 91 units per pound of meat.

The total quantity of air circulating through the rooms per day of 24 hours (23 hours work),

$$37{,}500 \times 23 = 862{,}500 \text{ cubic feet.}$$

(Taken at a temperature of 50° Fah. after passing over the drying pipes.)

Quantity of heat to be removed per cubic foot of air, 686,974 ÷ 862,500	Unit. 0·7966
Thermal equivalent of air at 50°, by column 9 in table 3	lb. 0·0185
Rise in temperature in degrees Fah., due to the absorption of ·7966 unit ÷ ·0185 ...	43·3°
Rise in temperature due to leakage through the walls	13°
Rise in temperature due to the abstraction of heat from the meat	43·3°
Total rise (theoretical) ...	56·3°

Average temperature of cold air on leaving the expansion cylinder (six weeks' actual observation)	− 79°
Rise in temperature of the air that should occur for leakage and the abstraction of heat from the meat	56·3°
Theoretical temperature of the returning cold air after passing through the rooms ...	− 22·7°
Actual temperature as evidenced by six weeks' work	+ 13°
Difference due to leakage, &c.	35·7°

As the difference in temperature between the atmosphere and the cold air is about 150°, a loss of 35° forms 23 per cent. of the total work of the engine.

APPENDIX C.

As an illustration of the reduced cooling power of meat as the thickness increases, and also of the increased time required for the abstraction of the heat from a thick hindquarter, as compared with the ribs and flanks, the following calculations are given :—

Weight of 1 cubic foot of meat	66 lbs.
Weight of 1 quarter (average)	180 lbs.
Area of surface of a forequarter	22 sq. ft.
Area of surface of a hindquarter	16 sq. ft.

TABLE 7.—Register of the temperature of the rooms at Queensport during 9 days, when charged with meat, from an average of 6 weeks working, during September and October, 1884. The temperature taken every 12 hours, up to the fifth day.

1st day		2nd day		3rd day		4th day		5th day		6th day	7th day	8th day	9th day
32°	25°	22°	19°	18°	17°	16°	15°	12°	10°	8°	5°	3°	0°

TABLE 8.

Thickness in Inches.	Weight in Pounds.	Total number of units of heat lost by 1 square foot of meat of the following thicknesses in falling from—					
		98° to 32° Unfrozen.	70° to 32° Unfrozen.	32° Water to 32° Ice.	Difference between Internal and External Surfaces.	Total. 98° to 32° Frozen.	Total. 70° to 32° Frozen.
1	5·5	193	111	283	8	484	402
2	11	386	222	566	23	975	811
3	16·5	579	333	849	46	1474	1228
4	22	772	445	1132	69	1973	1645
5	27·5	965	556	1415	96	2476	2066
6	33	1158	668	1698	128	2984	2493
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

Column 5 in the above table requires a little explanation. It is evident that if meat is hanging in an atmosphere the temperature of which is, say, 0° Fah., and the *interior* surface of the meat just frozen, the exterior surface must be approximating in temperature to that of the air. From the formula

$$t' = \frac{(C \times t) + (Q \times E \times T')}{C + (Q \times E)}$$

where t=internal surface, t′=external surface, T=internal air, T′=external air, the temperature of the exterior surface can be found. Taking the specific heat of frozen meat at ·35, the number of units to be removed to bring the *average* temperature down to the mean between t′ and t, is given in column 5.

In the following table the flow of heat through meat of different thicknesses, with the air temperatures as given below, and with various internal surface temperatures, is also given.

$$C' = \left\{ \frac{Q \times (t - T')}{\left(1 + Q \times \frac{E}{C}\right)} \right\}$$

Value of Q.

For temperatures ... 0° & 98° = 1·93
For temperatures ... 32° & 98° = 1·95
For temperatures ... 32° & 70° = 1·8
For temperatures 28° to 0° & 32° = 1·7

TABLE 9.

Thickness in Inches.	Flow of heat through meat of the following thicknesses, with different temperatures of air and internal surfaces, as given below. The emission calculated as from one side only; in units per square foot of surface per hour.										
	Temperature of the air in the room.										
	0°	32°	32°	28°	24°	20°	16°	12°	8°	4°	0°
	Temperature of the internal surface of the meat.										
	98°	98°	70°	32°	32°	32°	[illegible]	32°	32°	32°	32°
1	140	95	51	5	10	15·5	21	26	30	36	40
2	112	74	41	4	8	12·5	16·5	21	24	28	33
3	93	61	34	3.5	7	10·5	14	17	20	24	27
4	80	52	29	3	6	9	12	15	17	21	23
5	70	45	25	2·6	5·3	8	10·5	13	15	18	20
6	63	40	22	2·3	4·7	7	9	11·5	13	16	18
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

The emission being reckoned from one side only, for the convenience of calculation, the flow from both sides can be ascertained by taking *one-half* the thickness, and doubling the units corresponding to that thickness. For instance, to ascertain the flow of heat through a piece of meat four inches thick with the emission proceeding from both sides; this is equivalent to the emission from a piece two inches thick with the flow proceeding from *one* side only but of double the area.

It should be noted that when once the temperature of the internal surface is lowered to 32°, it remains at that point until the last portion is frozen (owing to the abstraction of the latent heat of liquefaction), consequently the temperature of the internal surface can be taken throughout at 32°.

The tables 10 and 11 (pp. 58, 59) show the process of freezing—first, when meat is hung in a room, the temperatures of which correspond with the actual daily results as obtained at Queensport; and, second, when the meat is hung in the open air at a temperature approximating to that of the freezing chamber *when empty*, say, at about zero. Observations of the temperature obtained at Queensport show that the empty rooms could not be reduced much below zero without considerable improvement being made to the insulation.

On examining the difference in actual cost of working when meat is placed in a freezing room immediately after killing, say, at a temperature of 98°, as compared with its chilling when put in at 70°, it will be found that 1lb. of coal used in the cold air process will make about 2lbs. of ice, or, what is the same thing, will remove 350 units of heat. Taking 42 quarters, weighing 7,500 lbs., as the average daily charge during the last shipment at Queensport, if this quantity is put into the rooms at a temperature of 98° instead of 70°, the difference in units of heat to be removed would be $7{,}500 \times 28 \times .53 = 111{,}300$ units. As 1lb. of coal removes 350 units, $111{,}300 \div 350 = 318$ lbs. of coal would take away the excess of heat between 70° and 98°. Allowing for loss by friction, etc., due to increased compression, and calling it 4 cwt., it will be seen that the extra cost of reducing the temperature of the meat from 98° to 70° in the freezing room, instead of allowing it to cool in the open air, is very small.

A comparison of tables 10 and 11 will show the reason why meat takes so much longer to freeze in a chamber than when hung in the open air, when the temperature of the external atmosphere and that of the empty chambers are about the same. Taking the temperature in both cases to be, say, zero, meat hanging in the open air is exposed to the contact of air *at zero during the entire operation*, no rise taking place in the air temperature, as the volume of air circulating is practically infinite, as compared with the limited quantity passing through the chambers. In the case of meat hanging in the chambers, the heat given off by radiation to the walls, and by contact to the air, necessarily warms the limited quantity of air circulating, as shown in the table of air temperatures (table 7). In the case where a wind is blowing upon meat hanging in the open air, the loss by contact becomes very much greater, depending, of course, upon the velocity of the wind. The value of Q, in the formula given, being increased in proportion.

In endeavouring to trace the rate at which the emission proceeds from the surface of meat hung in a cold atmosphere for the purpose of being chilled, it will be convenient to divide the process into three parts. The *first* part (A) of the operation will be that in which the heat is dissipated from the external surface, gradually lowering the temperature of the whole mass, proportionately to the thickness, until the temperature of the internal surface commences to fall below 98°; when this occurs the temperature of the external surface will, of course, be considerably lower than that of the internal surface, but not as low as that of the air in which it is hung. The *second* part (B) will comprise the abstraction of the heat until the internal surface is reduced to 32°, but not frozen; and the *third* part (C) of the operation will be that in which the whole mass is frozen, and which will also necessarily include the fall of the external surface considerably below 32°; the heat lost during this latter part of the process being given in units in table 8, col. 5.

1ST.—THE RATE OF THE EMISSION OF HEAT AT THE COMMENCEMENT.

The formula for ascertaining this is—

(a)

$$Q \times (t' - T') = 1{\cdot}95 \times (98 - 32) = 129 \text{ units}$$

per square foot per hour.

This is the rate at which the heat is lost at the commencement. As the surface of the meat, whatever the thickness may be, emits the same amount of heat *at the commencement*, this formula covers the flow for all thicknesses at the beginning of the operation.

From the formula, $\dfrac{(C \times t) + (Q \times E \times T')}{C + (Q \times E)}$

can be ascertained the temperature of the external surface of the meat when that of the internal surface has commenced to fall below 98°. This is now given for thicknesses from 1 to 6 inches.

(b)

Thickness in inches	1	2	3	4	5	6
Temperature of the external surface	80°	70°	64°	59°	55·5°	52°

By the formula Q × (t′ – T′) as above, the rate of emission at this point of the process is ascertained. It is as follows, in units:—

(c)

Thickness in inches ...	1	2	3	4	5	6
Flow of heat in units per square foot per hour	95	74	61	52	45	40

Having found the rate of emission at the commencement, and at the point where the temperature of the internal surface is commencing to fall below 98°, the *average rate* of the flow is obtained. This is as below, in units:—

(D)

Thickness in inches ...	1	2	3	4	5	6
Average flow in units per square foot per hour	112	102	95	90·5	87	84·5

From the temperature of the external and internal surfaces at this point the average temperature of the mass can be found, and from that, the average fall from 98°. This is now given, and also the number of units of heat removed during the interval.

(E)

Thickness in inches ...	1	2	3	4	5	6
Average temperature ...	89°	84°	81°	79°	77°	75°
Fall from 98°	9°	14°	17°	19°	21°	23°
Heat lost in units ...	26	82	148	233	320	402

The average rate of the emission being found, and the number of units of heat to be removed being also shown, the time required is obtained.

(F)

Thickness in inches	1	2	3	4	5	6
Time in hours ...	0·2	0·8	1·6	2·6	3·7	4·8

2ND.—THE REDUCTION OF THE INTERNAL SURFACE TO 32°.

The total number of units of heat to be abstracted from meat of various thicknesses in bringing the temperature down to 32° being shown in table 8, and also the loss during the first part of the process having been ascertained (E), the remainder is that to be abstracted during the second part of the operation. This is now given :—

(G)

Thickness in inches	1	2	3	4	5	6
Units to be removed	169	304	431	539	645	756

The flow of heat at the end of the first part of the process being given in (c), and also the emission, when the internal surface temperature has fallen to 32° (table 9), varying with the temperature of the air and the different thicknesses, the average rate of the flow for the second part is thus obtained :—

(H)

Thickness in inches ...	1	2	3	4	5	6
Flow at commencement in units	95	74	61	52	45	40
Flow when the internal surface is at 32°. From table 10	0	0	2	3	4	5
Average flow	47·5	37	31·5	27·5	24·5	22·5

Knowing the average rate of emission (H) and the total number of units to be removed (G), the time required is thus obtained.

(K)

Thickness in inches ...	1	2	3	4	5	6
Time in hours ...	3·6	8·3	14	19·5	26·3	33·6
Time for the 1st part of the operation ...	0·2	0·8	1·6	2·6	3.7	4·8
Total time required to bring the internal surface down to 32	3·8	9·1	15·6	22·1	30	38·4

3RD.—FREEZING THE WATER CONTAINED IN THE MEAT.

The temperature of the external surface being approximately 32° (the amount of the latent heat of liquefaction to be removed from the water contained in the meat retarding the fall), and that of the internal surface being also at 32°, the *apparent* fall in temperature at this point is very slow. Table 10 gives the rate, which is a progressive one, as the air temperature gradually falls. Taking the temperature as recorded in table 7, it is easy by the formula:—

$$\frac{Q \times (t - T')}{1 + \left(\frac{Q \times E}{C}\right)}$$

which is based upon the temperatures of the internal surface and the air, to calculate the amount of heat abstracted day by day, and the following table summarises the whole operation, until the internal surface is frozen, the external surface as explained in the note to table 8 being proportionately lower.

It should, however, be noted that these calculations can only be considered as approximate. Until the values of R, A, and C are thoroughly settled it is not possible to deal with the question as absolutely correct. At best one can only indicate the lines upon which further investigations will probably be made.

To ascertain the true values of R, A, and C of meat hanging in a freezing room for the purpose of refrigeration, is a problem that can best be solved by those in charge of an establishment where a complete and exhaustive series of experiments can be carried out under the varying conditions of actual working. It is a matter well worth attempting, and the attention of those interested in the subject should be called to the necessity for thoroughly investigating these points.

TABLE 10.

Emission of heat from meat of various thicknesses when hanging in a freezing room. The temperature of the meat when put in =98°. The temperature of the empty room =0° Fah. The temperature of the room rising to 32° when the meat is put in. The emission calculated as proceeding from one side only. In units per square foot per hour.

	Flow while falling to 32.													Time.	Flow while Freezing.												Time.	
	A.					B.									C.													
Thickness in inches.	Flow at the commencement (A).	Flow when internal surface commences to fall below 98° (C).	Average flow (D).	Units of heat to be removed (E).	Time required in hours (F).	Flow when internal surface commences to fall below 98 (C).	Temperature of the Air. 1st day.		2nd day.		3rd day.	Average flow while internal surface is falling to 32° (H).	Units of Heat to be removed (G).	Time required for the internal surface to fall from 98° to 32° in hours.	Temperature of the air. 1st day		2nd day		3rd day		4th day	5th day	6th day	7th day	8th day	9th day	Time required to freeze the internal surface.	Total time required to fall from 98° to 32°—Frozen.
							32°	28°	24°	20°	18°				32°	28°	24°	20°	18°	17°	15°	10°	8°	5°	3°	0°		
							Temperature of the internal surface of the meat.								Temperature of the internal surface of the meat.													
							32°	32°	32°	32°	32°				32°	32°	32°	32°	32°	32°	32°	32°	32°	32°	32°	32°		
1	129	95	112	26	0·2	95	0	Freez	ing	...	...	47·5	169	3·6	...	5	10	15·5	Fro	zen	...	...	...	...	...	...	32	36
2	129	74	102	82	0·8	74	0	Freez	ing	...	...	37·5	304	8·3	...	4	8	12	13·5	15	Fro	zen	...	...	...	...	57	65
3	129	61	95	148	1·6	61	...	2	Freez	ing	...	31·5	431	14	...	3·5	7	10	11·3	12·6	14·3	17	Fro	zen	...	...	82	96
4	129	52	90·5	233	2·6	52	...	3	Freez	ing	...	27·5	539	19·5	...	3	6	9	10	11	12·4	16	17·5	Fro	zen	...	105	124
5	129	45	87	320	3·7	45	...	...	4	Freez	ing	24·5	645	26·3	...	...	5·3	8	8·8	9·6	11	14	15·4	17·3	Fro	zen	128	154
6	129	40	84·5	402	4·8	40	...	...	5	Freez	ing	22·5	756	33·6	...	...	4·7	7	7·8	8·6	9·7	12·6	13·8	15·5	16·5	Frz	152	186

TABLE 11.

Emission of heat from meat hanging in the open air. Temperature of the air = 0° Fah. Temperature of the meat when put in = 98°. The emission calculated as from one side only, in units per square foot per hour. *In still air.*

Thickness in Inches.	Flow while falling to 32°.								Flow while freezing.		Total.
	A				B				C		Time.
	Flow at the commencement (A).	Flow when the internal surface commences to fall below 98° (C).	Average flow (D).	Time required in hours (E).	Flow when the internal surface commences to fall below 98° (C).	Flow when the internal surface is at 32°.	Average flow while internal surface is falling to 32 (H).	Time required for the internal surface to fall from 98° to 32°, in h'rs	Flow when the internal surface is at 32°.	Time required to freeze the internal surface.	Total time required to fall from 98° to 32°. Frozen.
1	191	140	165	0·23	140	46	93	1·7	46	6·4	8·3
2	191	112	151	0·8	112	37	74·5	3·6	37	16	20·4
3	191	93	142	1·5	93	31	62	5·8	31	29	36·3
4	191	80	135	2·4	80	27	53·5	8·3	27	45	55·7
5	191	70	130	3·5	70	23	46·5	11	23	66	80·5
6	191	63	127	4·5	63	19	41	14·2	19	96	114·7

As no objection is raised by the advocates of the "freezing-in theory" to meat being hung in the open air at a temperature about freezing point, it would be instructive to know in what way, if any, the above condition differs from the case as illustrated in table 10, where the temperature, as actually observed, did not fall below freezing point for more than 12 hours. A careful comparison of tables 10 and 11 will show the weakness of their argument in reference to this subject.

AN INQUIRY INTO THE MAIZE DISEASE OF THE CABOOLTURE DISTRICT;

BY

J. BANCROFT, M.D.

(*Read on 4th June.*)

ON March 29th, 1886, I received a request from the Honourable the Colonial Secretary, Sir S. W. Griffith, to inquire into the causes of the maize blight reported to have visited the Caboolture district, leading to nearly an entire loss of yield of grain in the affected crops. I received also, from the Divisional Board of Caboolture, samples of diseased maize and the following communication :—

"Mr. Litherland will bring you some samples of diseased maize. Those No. 1 show the disease in the young plant; No. 2, older; No. 3, at this stage the disease makes rapid growth, the leaves are soon killed, the cob does not fill out, and the consequence is a very light grain. No. 4 is quite a different disease, known among farmers as the 'Curl.' It has made considerable havoc among the maize crops the last year or two. We think the disease is in the roots, as the plants seem unable to take proper hold of the ground and break off very easily.—G. W. MALLETT, Caboolture, 14th April."

On examination of the curly disease, the young unfolding leaves were found to be covered with little enlargements, but thrips—insects, which had possibly led to this curled condition, were not observed.

No disease fungus could be found on the roots of the maize plants. The foliage had dead strips running longitudinally in parts of the leaf; but how this was caused was not evident, whether by bruising from wind or by some obstruction of the vascular tissue. No fungus was found on the foliage and no appearance of rust like that on wheat and oats, a condition occasionally to be found on maize leaves in summer, as I have frequently noticed in former years.

Caterpillars were seen in the immature ears as well as in the stems.

The abnormal appearances thus noticed resolved themselves into three.

1. The curly and nasty condition of the upper foliage.

2. Dead strips in the older leaves.

3. Caterpillars in the developing ears, and the same boring into the stems.

To clear up the matter, I visited a maize field near Luggage Point, and carefully inspected a blighted crop. Here every stem of maize was perforated by caterpillars, and it was clearly evident that, the stalks being bored extensively, both below the ears and between them and the upper flower, they had spoiled all chance of grain development. I reared a number of the caterpillars from these bored stalks as well as some from the abortive ears.

On April 19th I telegraphed to the secretary of the Farmers' Association at Caboolture, asking him to kindly examine if all the blighted maize stalks were perforated by boring caterpillars, and received the following reply :—

"On examining the maize, I find a good many affected with the boring caterpillar you speak of. They have been more or less prevalent in the late maize crops for years. I do not think they have much to do with the rust, with the exception of weakening the plant, and which is consequently less able to resist the rust I find that maize that has been well worked and kept perfectly clean, although badly rusted, will yet mature a fair cob, but even these patches of maize are much lighter than they should be for the labour bestowed upon them.—G. W. MALLETT, Caboolture, 22nd April."

As this statement gave me no assistance, I asked Mr. Price Fletcher, of the *Queenslander* newspaper, to interrogate the farmers he came in contact with, and the replies given to him by a number of intelligent observers were to the effect that the caterpillars had extensively bored the stems of all the blighted crops. The grubs, which I had previously collected at Luggage Point, were kept under observation, and on May 1st resolved themselves into orange-coloured moths with black spotted wings—the same that had been found eating the unripe peaches for several seasons past.

Mr. H. Tryon, assistant curator of the Museum, at the same time hatched out the moth from maize stems, and one specimen from the stalk of a dahlia.

A single example also was hatched out by myself from caterpillars found feeding on the senna bean (*Phaseolus gladiatus)**. This moth, which may be known as the peach moth, has been referred to Dr. Lucas, of Melbourne, and he informs me that it belongs to the Pyralidæ, and is named *Conogethes punctiferalis,* Guenee.

It was thought that this moth, which eats apples as well as peaches, might be the codlin moth of Europe and North America, but I am informed at the Museum that the latter is an entirely different insect.

The caterpillar, when feeding on unripe peaches, may be observed to tie several fruits together, making burrows in their substance. The peaches never ripen, do not fall off the branches, but remain hard and dry on the tree for months. The grubs soon hatch out into the moth form, seeking later peaches, apples, maize or other succulent vegetable matter to lay their eggs in. The eggs are also laid on the female tassle of the maize, the grubs developing therefrom finding a home at the point of the developing ear. Should the maize be insufficiently advanced the grub will bore the maize stalk, as we find by the experience of this season.

From the early maize a large flight of moths is probably developed that attack the later maize, and so the chief crop may be destroyed.

What can therefore be done to reduce the risk of general maize destruction? Clearly it will be necessary to husk the early crops of maize as soon as possible, destroying the grubs by hand or by passing the ears through the maize sheller. It would be advisable also to look to the peach trees and remove the fruit infested by the caterpillars.† With regard to the late crops of maize, it would be well to clean it also, and, if not shelled, the husk should be taken off the ears and the grubs destroyed wherever found bur-

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* This bean has suffered much during the present season from caterpillars, which bore into the ripening seeds. They become small brown moths.

† The small maggot that eats ripe peaches is of another order of insects, and does not now concern us. It develops into a two-winged fly that, on casual inspection would pass for a small wasp.

rowing in the cob and among the grain. Burning of maize stalks may again be a reasonable act.*

Much yet remains to be done before our knowledge of the various succulent-stemmed plants that support the Conogethes caterpillar will be complete. So far, it appears that the caterpillar is one that adapts itself to civilisation—boring into many cultivated plants. It is not likely to disappear from our field and gardens, and cultivators would do well to study its life history with care.

EXHIBITS.

By Mr. L. A. Bernays. Fruiting branches of Antidesma Dallachyanum, *Baill.*, the Herbert Vale Cherry, from plants growing at Brisbane; the pleasantly acid drupes being available for making jelly, and as the source of a grateful beverage.

By Dr. Bancroft. Two species of moths bred from caterpillars destructive to the sugar-cane and an imported bean (Phaseolus gladiatus) respectively.

By Mr. J. Thorpe. A copy of the record of a self-registering barometer, made at Brisbane during May, with indications of the successive meteorological conditions throughout Australia for the same period.

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* Burning the cane trash destroys the borer and other parasitic insects of the sugar-cane. This sugar-cane borer develops into a brown moth. I have not found the peach moth to attack the sugar-cane.

ANNUAL MEETING, 2ND JULY, 1886.

THE PRESIDENT L. A. BERNAYS, F.L.S., IN THE CHAIR.

THE following Report of the Council and Balance-sheet were read and afterwards, on the motion of E. Palmer, M.L.A., seconded by W. A. Tully, F.R.G.S., B.A., adopted.

TO THE MEMBERS OF THE ROYAL SOCIETY OF QUEENSLAND.

GENTLEMEN,—Your Council have pleasure in congratulating you on the satisfactory progress of the Society since the date of the last annual meeting.

On the books of the Society there are now 146 members —inclusive of 25 whose subscriptions for 1885 are still in arrear, and exclusive of 5 who have retired.

A census of the Society gives the following results :—

Corresponding Members	1
Life Members (of late Queensland Philosophical Society)	13
Life Members (compounded)...	11
Ordinary Members	121
Total	146

The number of new members elected during the past year was 38.

It will be seen from the Financial Statement appended that there is a balance in the hands of the Treasurer of £98 15s. This amount is, however, chargeable with liabilities already incurred.

Your Council would then avail themselves of the opportunity to respectfully urge upon those whose subscriptions are in arrear the desirability of maintaining the credit of the Society.

On the side of Expenditure will be found the item "Editing Publications, 1884-5." This grant was made to the Honorary Secretary in August, 1885, but the Council are still under obligations to this officer for much painstaking services which cannot be repaid by a money grant.

The ordinary monthly sittings—nine in number—have been fairly attended, the average number present being 20, exclusive of visitors. At these meetings twenty-two Papers have been read on the following subjects :—

Ethnology	3
Zoology	7
Geodesy	1
Meteorology	1
Geology (including Palæontology and Hydrology)	5
Applied Science	1
Botany (including Agriculture)	5

Three of these Papers have been contributed by gentlemen who are not members of the Society, to whom, accordingly, your thanks are especially due.

In addition to these papers, short notices on isolated subjects have from time to time been presented at the meetings.

The second volume of the Society's Proceedings has been published, and is being issued to the members, and distributed to societies and public scientific institutions, many of which have furnished publications in return.

By this system of exchange, and by the liberality of private donors, the library of the Society has been enriched by the reception of 148 books, pamphlets, or papers—received from 24 societies, 11 Government Departments, and 10 individuals. Particulars of these accessions, which include works of great value, have been announced from time to time in the Monthly Abstracts of the Society's Proceedings.

In view of the rapidly increasing dimensions of the library, and for the purposes of the Society generally, your Council applied in March to the Government for the use of a room, and learnt with regret that no suitable one was available. With this end in view further measures, however, have since been adopted which are likely to be successful.

For the purpose of giving the members more ready access to the books possessed by the Society, the Council appointed, in December last, an honorary librarian in the person of

Mr. H. H. A. Russell, who had expressed himself as willing to perform the duties connected with that post.

Your Council have held thirteen meetings, and amongst their labours early addressed themselves to the work of preparing an amended Code of Rules, as suggested at the last Annual Meeting. This Code of Rules, the emendations contained in which are familiar to you, was circulated amongst the members in October 1885.

The resignation of their respective offices by the Treasurer, Mr. W. D. Nisbet, and Mr. R. C. Ringrose, owing to absence from town, was accepted with regret.

As the result of a previous suggestion made to the Council, a Forbes Expedition Aid Fund was opened, on the invitation of the President, at the monthly meeting of the members held on 4th December, 1885, and the Honorary Secretary appointed Treasurer thereof. Subscriptions to this Fund, at the time of its being closed, had already amounted to £94 13s. 6d., when further appeal was received on behalf of Mr. H. O. Forbes, whose operations in New Guinea had been suspended. This led to the Fund being re-opened, with the result of additional subscriptions being received, raising the total to £145 10s. One hundred pounds of this amount has already been forwarded to Mr. Forbes, and the receipt of the same acknowledged by him.

Such is a brief statement of the work of the Society during the past year.

Signed on behalf of the Council,

LEWIS A. BERNAYS,

President.

ROYAL SOCIETY OF QUEENSLAND.

Balance Sheet of Receipts and Disbursements for the Year ending 2nd July, 1886.

Dr.

	£	s.	d.	£	s.	d.
To Balance 10th July, 1885				87	14	5
Members' Subscriptions	40	19	6			
Members' Compositions	15	15	0			
Members' Entrance Fees	21	3	0			
Members' Subscriptions, 1886	28	7	6			
Members' Entrance Fees, 1886	5	5	0			
				111	7	0
Total				£199	1	5

Cr.

	£	s.	d.	£	s.	d.
By Printing and Binding Proceedings, Miscellaneous Printing and Stationery ...	43	16	0			
Editing Publications, 1884-5	25	0	0			
Illustrating Proceedings Vol. II. ...	20	17	0			
Advertising, Miscellaneous Postage and Small Accounts	10	13	4			
				100	6	4
Balance				98	15	1
				£199	1	5

I, having this day examined the Accounts of the "ROYAL SOCIETY OF QUEENSLAND," find the above statement to be correct, and that a balance of £98 15s. 1d. remains in the hands of the Treasurer.

BRISBANE, *2nd July, 1886.*

(Signed) D. O'CONNOR, *Auditor.*

Mr. E. Palmer, M.L.A., then moved, and Mr. W. A. Tully seconded, the adoption of the Report of the Council and Balance Sheet, and these were adopted unanimously.

The President, Mr. L. A. Bernays, then delivered the following address:—

PRESIDENT'S ADDRESS.

In a young society like ours, it would, I think, be unwise to expect the President for the year to give a formal address upon his retirement. There are many members of the Society who would make good organising heads, and could conduct its meetings efficiently and with dignity, who would not accept the office if a formal presidential address were required from them at the end of their term. In my own case I have not the leisure to follow carefully the progress of the various branches of science which we are formed to promote; nor have I the exact knowledge of any of them which alone could justify my presuming to pass them in review before a critical audience. I have, however, a few words to say before giving way to my successor, and will make them as few as possible. A branch of the Geographical Society of Australasia having been established in Brisbane, and giving tokens of vitality, that phase of scientific research may be considered provided for, and this Society has been relieved from its prosecution. When, however, it became known that the scientific investigations being conducted by Mr. H. O. Forbes in New Guinea were likely to be hampered, if not brought to an end, from want of funds, it was thought to be well within the scope of our functions that we should lend the weight of our organisation to the collection of subscriptions for the purpose of enabling that very able investigator to continue in New Guinea the admirable work which he had so successfully carried out in the Eastern Archipelago. Although the result of our efforts proved insufficient to ward off the threatened calamity, the Royal Society of Queensland is entitled to the credit of having been the first, and, as far as my information goes, the only one of the various scientific organisations of Australasia, to take the practical step of organising a fund for this purpose. It is to be hoped that before the season recurs at which Mr. Forbes could effectively renew his work the necessary funds may be forthcoming to give him a fresh start, and a reproach be thereby removed from this group of colonies which is so intimately concerned in the accurate development of the geography and natural history of British New Guinea. We may rest well assured that the scientific enterprise of our German neighbours there will never rest until both the geography and the natural history of their portion of the country is well known and accurately recorded ; and in the accomplishment of this end, the great national capacity for scientific exploration and investigation will, doubtless, be substantially aided by the German Government, if even the entire work will not be undertaken by the State. A revision of the rules has included the adoption of a new rule giving to the council the power to establish sections for the furtherance of original research. It is matter for regret that this change has not yet borne fruit, but as we become stronger in members who are specialists, it may be expected that sections will be formed. There is no doubt that the best of scientific work is done by those who, whether by themselves or in association with others, devote their attention to the furtherance and elucidation of special subjects of research. The transactions of the year have been marked by the reading of a considerable number of papers, covering a large number of subjects. Biology has not occupied more than its fair share of the time of our meetings; while ethnology, meteorology, geology, botany, industrial botany and horticulture, pathology of plant diseases, forestry, &c., have each in their turn been the subjects of papers and of ensuing discussions. The Society has also been indebted to one of its members for a very valuable contribution on the science and art of preserving perishable articles of food by means of refrigeration. The exhibits at the meetings have been varied and instructive, and for these we are much indebted to our excellent colleagues, Mr. C. W. De Vis, Curator of the Queensland Museum, and his coadjutor, Mr. H. Tryon, our honorary secretary. Mention of the museum reminds me that the society is under an obligation to the trustees of the museum for permission to meet in their library; but I would urge upon my successor and the council for the coming year the need for something more than a suffrance occupation of a *locus in quo*. I am not without hope that an arrangement may be come to by which we may lease the right to meet and to shelve our books in the convenient room which, by the kind permission of the Right Rev. Dr. Webber, Bishop of Brisbane, we are occupying to-night. Our library comprises a large number of books, periodicals, reports, catalogues, &c., on scientific subjects, which, for want of arrangement and facility of access, are practically useless; and as it appears that the labour of evolving order out of the chaotic mass of material which we have collected, has warned one honorary librarian after another off the task, we might with advantage apply some of our funds to a work which, when done, would have much value to members in rendering available for research a large amount of printed matter which is at present practically useless. I have very little doubt that another good effect of arranging and cataloguing our library would be to encourage its increase by donations of books from our members; while the existence of a library of reference available for research would lead to the candidature of new members for enrolment. I am unwilling to test your patience much further, but I cannot let pass this opportunity of adverting to a matter upon which I feel warmly and upon which I must not hesitate again to speak in plain terms, as I have both spoken and written before on various occasions. This colony enjoys the unenviable pre-eminence of being the only one with self-government in the Australasian group which does nothing systematic to foster, by teaching, the numerous industries which our marvellous range of soil and climate is capable of calling into existence. New South Wales, Victoria, South Australia, Tasmania, New Zealand, have each among their public servants men combining these qualifications of science and practical knowledge which, in matters affecting the cultivation of the soil, are of late years—owing chiefly to the example of Kew—so often to be found in the same individual, and which when rightly directed afford such material aid to the farmer and the gardener in developing to their fullest extent the capabilities of soil and climate. The State in India and the Governments of some of the small Crown colonies relegate to the control of men combining high scientific attainments with the knowledge of a trained gardener, the whole of the State expenditure on gardens. There are no industries so calculated to increase the wealth of a young country as those involved in the development of the capabilities of the soil; and if this be admitted it is wonderful that the interests of those engaging in these industries should have been so neglected. It appears to have been thought that the duty of the State was performed by providing facilities for obtaining land, whereas in fact it had only then commenced. Mining has long had a State department to itself, with a staff of geological surveyors, grants to mining museums, diamond drills, and encouragement and assistance of all kinds; and yet as a source of national wealth mining is not to be compared in importance to the cultivation of the soil. In the one case the mineral is extracted and there is an end of the value of the land; but the intelligent and well directed cultivation of the soil is a practically inexhaustible mine of wealth. I do not hesitate to affirm that the time has long since come when agriculture and horticulture should have the advantage of State supervision and advice. I am not trenching upon the realms of politics in saying that I think this would be best effected by the creation of a Minister for Agriculture ; and that to make his administration more effective he should have at his elbow a man of the training and with the special qualifications which I have described. It is no reflection upon the admirable administration of Mr. De Vis, as curator of the museum, or upon the acknowledged services rendered to science by the labours of Mr. Bailey, as Government botanist, when I say that our museum is singularly defective in the absence of sections of technological and economic botany. There is no doubt a sufficient reason for this in the want of space ; but if I had the ordering of things, the mummies and the ethnological curios would give place to the legion of educational exhibits involved in the full meaning of those phases of museum illustration. We seem to be drifting farther and farther from the recognition of science-with-practice in the cultivation of plants as a subject deserving inclusion in our educational system. At one time we made a pretence at a botanic garden ; a poor one I admit, but there was at least the recognition of the principle that it should possess educational features. Now the pretence is not even left, and it has become a mere garden and promenade. It may be said that, as one of the trustees, I am partly responsible for this ; but, while not thinking it necessary to refuse my assistance in managing the gardens in their present form, my views of what they should be were given formally to the Government, from whom I accepted the appointment, and are on record. I must not close my remarks without bearing testimony to much that has been done by our valued colleague, Dr. Bancroft, to aid the labours of the tiller of the soil in Queensland by throwing light upon some of the hindrances to successful cultivation, and by his pioneer experiments with new plants and new species. I should much like to see the various papers and leaflets which from time to time have issued from that gentleman's pen brought together, as they would form a highly interesting and instructive volume.

A vote of thanks having, on the motion of Mr. R. Roe, been unanimously accorded to Mr. L. A. Bernays for his address, the following Officers and Council for the ensuing year were then elected:—

President, A. Norton, M.L.A. ; *Vice-President,* C. W. De Vis, M.A.; *Council,* F. M. Bailey, F.L.S.; L. A. Bernays, F.L.S.; J. Tolson, Esq.; Richard Rendle, F.R.C.S.; W. A. Tully, B.A., F.R.G.S. Dr. J. Bancroft was appointed *Treasurer,* a second nominee having been declared ineligible through absence from the colony ; and Mr. Henry

Tryon was re-appointed *Honorary Secretary*, no other member being nominated for that office.

On the motion of Mr. W. A. Tully, Mr. D. O'Connor was appointed auditor of the Annual Financial Report of the Treasurer.

FRIDAY, 6TH AUGUST, 1886.

THE PRESIDENT, A. NORTON, ESQ., M.L.A., IN THE CHAIR.

The Chairman briefly acknowledged the honour conferred upon him in his election to the post of president at the annual meeting.

NEW MEMBERS.

Mr. W. H. Rands, F.G.S., A.R.S.M.; and Lieutenant-Colonel E. R. Drury, C.M.G.

DONATIONS.

"Occasional Papers on the Flora of Queensland," No. 1, by F. M. Bailey, F.L.S., etc. Brisbane, 1886. From the Author.

"Detailed Catalogue and Guide to the Geological Exhibits in the New Zealand Court, Indian and Colonial Exhibition, 1886," by James Hector, C.M.G., M.D., etc. Wellington, 1886. From the Author.

"Proceedings of the Canadian Institute," 3rd Series, Vol. III., fasc. 2 and 3. Toronto, 1885-6. From the Institute.

"Proceedings of the Linnean Society of New South Wales," 2nd Series, Vol I., Pt. 1. Sydney, 1886. From the Society.

"Transactions and Proceedings and Report of the Royal Society of South Australia," Vol. III. Adelaide, 1886. From the Society.

"Annali del Museo Civico di Storia Naturale di Genova," Series 2, Vol. II. Genova, 1885. From the Director of the Museum.

"The Chemist and Druggist of Australasia," Vol. I., No. 6. Melbourne, 1886. From the Editor.

"List of Members of the Geographical Society of Australasia, &c." Melbourne, 1886. From the Society.

"Twelfth Report of the Acclimatization Society of Queensland." Brisbane, 1886. From the Society.

"The Australian Irrigationist," Nos. 21, 22, 23 and 24. Melbourne, 1886. From Mr. W. Weedon.

"Select Extratropical Plants," by Baron Ferd. Von Müller, K.C.M.G., M.D., PH.D., F.R.S., etc.; New Victorian Edition. Melbourne, 1885. From the Author.

"Summary Report of Operations of the Geological and Natural History Survey to 31st December, 1885." Ottawa, 1886. From the Director.

"The Fourteenth Annual Report of the Board of Directors of the Zoological Society of Philadelphia." Philadelphia, 1886. From the Society.

"The Journal of Conchology,," Vol. V., No. 2. Leeds, April, 1886. From the Conchological Society of Great Britain.

"Presidential Address" (Roy. Soc. N.S.W., 5th May, 1886), by Prof. Liversidge, F.R.S., President. From the Author.

"Victorian Naturalist," Vol. III., No. 3. Melbourne, July, 1886. From the Field Naturalist's Society of Victoria.

"Russkago Geographeskago Obshtchestva," Pt. 3, 1885. St. Petersburg. From La Sociéte Imperiale Russe de Geographie.

"The Gold Fields of Victoria—Reports of the Mining Registrars for the quarter ending 31st March, 1886." Melbourne, 1886. From the Secretary of Mines and Water Supply.

"Bulletin of the American Geographical Society, 1886," No. 1. New York, 1886. From the Society.

"Appendix to the Catalogue of Exhibits (Colonial and Indian Exhibition, 1886, Queensland Court)." Brisbane, 1886. From the Queensland Commissioners.

The following papers were read :—

ON A FEMUR PROBABLY OF THYLACOLEO;

BY

C. W. DE VIS, M.A.

(Read on 6th August, 1886.)

(PLATES III. AND IV.*)

ANY part presumptive of the skeleton of Thylacoleo deserves attention; if it be one with a promise to throw light on the mystery of the animal, so much more is it welcome, and few relics are better able to do so than a well preserved femur. Such is the fossil under observation, but since it comes before us with a pretension like this and is, as usual with those from the Darling Downs, an isolated bone, it behoves us to ascertain with proportionate care whether there are reasonable grounds for believing it to have been the growth of Thylacoleo.

Fortunately we have not far to seek for a sufficient token of its marsupiality; we find it in the transversely-undulated surface of the inner condyle. But the presence here of a longitudinal groove formed by such undulation may be thought to prove too much for our purpose since we recognise it as a modification restricted (in its present degree) to the kangaroos and related evolutionally with the faculty of leaping. The suspicion germinated that the fossil is the femur of a kangaroo is, however, quelled at once by the absence of the characteristic cavity above the condyle, by that also of the quadratus tubercle, by the depression of the great trochanter, and by the whole facies of the bone.

The kangaroos (Hypsiprymnidæ inclusive) being disposed of, we might proceed to compare our fossil with the femurs of the remaining families, but the progressive steps of further elimination would be tedious to read, though they

* The figures represent the bone reduced in the proportion indicated, *i.e.*, 135 : 296.

may have been pleasant to take, and the observations following may suffice to persuade the osteologist that a record of the differences between the fossil and the femurs of the Phalangistidæ and Peramelidæ is not necessary. It is enough to say that, while as a whole the fossil femur stands alone, it comprehends largely, but to an unequal extent, elements of the two families left, the carnivorous dasyures and rhizophagous wombats. From among the dasyuridæ we may dismiss Thylacinus without hesitation, and with a little reserve Dasyurus itself as too widely differentiated. Sarcophilus on the one hand and Phascolomys on the other now remain as the limits of the comparison, to be instituted with the aid of brief description.

The bone is in general form unlike any recent femur known to the writer, inasmuch as it tapers gradually from the proximal end to the distal third-fifth, and is in its proximal moiety rather strongly curved, both inwards and backwards. A result of the inward curve is that the angle made by the axis of the shaft with that of the head and neck is considerably less than obtains in Sarcophilus and Phascolomys, and to the same degree approaches the angle normal in the kangaroo.

The articulating surface of the head is, from the inner front point of view, more than hemispherical, a feature distinguishing Sarcophilus from Phascolomys. Its upper surface is more widely and distinctly flattened than it is in the latter genus, and the circular area produced is more central. There is therefore no pit for a ligamentum teres near the posterior part of the periphery, as in Sarcophilus. The curve of the neck, as it passes into the great trochanter, is uninterrupted either by the deep groove of constriction seen in Sarcophilus or by the shallowed channel of Phascolomys. The prominent lesser trochanter is the termination of a broad elevated ridge running upwards and outwards to the top of the post-trochanterian fossa. This ridge is in the wombat (P. platyrhinus) represented by lineæ asperæ traversing a low turgidity of the bone, and is in its median half altogether wanting in Sarcophilus. The ridge, descending from the lesser trochanter, contracts in thickness gradually, not immediately as in the recent genera, curves suddenly outwards, and subsides on the middle of the posterior surface of the shaft at about the same relative distance from the lower (distal) end of the post-trochanterian fossa as in Sarcophilus. By this sudden curve of the ridge, the trochanter is rendered apparently more than usually prominent. In Phascolomys the ridge descends with a rather convex edge, much less obliquely (its directions in Sarcophilus being intermediate), and terminates low down on the inner edge of the hinder face of the shaft. The post-trochanterian fossa, vertical in the wombat, is in the fossil a little inclined, and were not this end of the bone inwardly curved the fossa would be even more oblique than in Sarcophilus. The great trochanter is, on its outer surface, regularly convex both transversely and longitudinally; its anterior edge forms a continuous ridge, the proximal half of which is in advance of the distal and gaining prominence, folds a little over forwards and forms one of the distinctive features of the bone from an anterior point of view. The trochanter terminates distally with a feeble tumidity, as in Sarcophilus, but situated lower upon the shaft. The tubercle familiar to us in the wombat is conspicuously absent. The trochanter, rising a little above the head, is more elevated and has a sharper apex than in Phascolomys, and in these respects resembles that of the recent carnivore, with which it further agrees in the separation of its apical portion from its anterior base by a deep groove which is but faintly marked in Phascolomys. But the form of the base, as a single and well-defined eminence, is better conserved in the latter genus than in Sarcophilus, in which it is partially divided by a sinuosity of the epiphysial suture.

The summit of the anterior surface of the shaft beneath the neck is, in the wombat, rather deeply concave. Sarcophilus and the fossil have in this part an equally moderate degree of concavity. They also present a similar oblique flattening of the inner foreside of the lower two-thirds of the shaft contrasting with its symmetrical convexity in Phascolomys. On the hinder surface, the pit immediately proximad of the inner condyle of Phascolomys, is not found in the fossil. The supracondylar concavity is shallower than in Sarcophilus, shorter than in Phascolomys. It is bounded on the inner side by an angular ridge rising from the condyle and merging quickly into the convex edge of the shaft above; externally, by a convex edge, as in Sarcophilus. This edge, however, becomes, at some distance from the condyle, a sharp ridge, which runs inwards upon the shaft and subsides in a low rough swelling (possibly the insertion of the quadratus) occupying the middle of the mid-fourth of the posterior face. Above this swelling, on the inner edge of the shaft, is the very small foramen for the interfemoral artery.

At the distal end of the bone sarcophiline affinities preponderate greatly—phascolomine are virtually absent. The most conspicuous feature of this extremity in the wombats, recent and extinct, is the superior length of the inner condyle whose articulating surface is on its inner side produced upwards into a gibbous prominence from which the epiphysial line slopes downward in its outward course. The writer is not aware of any other marsupial in which the inner condyle is the longer—in almost all, *e.g.*, Sarcophilus, it is distinctly the shorter, and our fossil obeys the general rule. In it also the inner edge of the articulating surface of this condyle is deeply sinuous above (anterior to) the middle of its length—marsupial femurs generally (excepting that of the wombat) show a similar sinuosity in varying degree and position, but none so strikingly parallel to that of the fossil as Sarcophilus. The anterior portion of the articulating surface of the outer condyle is as boldly but not as broadly convex as in Macropus, but in its backward course the convexity is interrupted by a depression of the outer two-thirds of the surface deeper than in Phascolomys but not, as in Sarcophilus, continued outwards as a groove upon the non-articulating surface. Behind the pit-like depression, the convexity is resumed; but quickly changes into the broad groove before mentioned which occupies the greater part of the surface. Unfortunately, the part which in Macropus forms the prominent outer lip of this groove and which would enable us to gauge its comparative depth, was broken off before burial (it is the sole imperfection of the bone), but it appears to have been somewhat less deep than in M. major. The intercondylar groove is relatively narrower and, instead of expanding mesially, is a little contracted by the convexity of the side of the outer condyle, its lesser and more uniform width is repeated in Sarcophilus, but is here rendered somewhat sinuous by a slight convexity of the outside of the inner and concavity of that of the outer condyle. There is no trace of the deep pit in the intercondylar groove present in Phascolomys.

COMPARATIVE MEASUREMENTS.

	Fossil. mm.	*Sarcophilus.* mm.	*Phascolomys.* mm.
Total length	296·0	109·0	160·0
Least width of shaft	24·0	8·0	14·5
Breadth of proximal end	71·5	28·0	46·0
Breadth of distal end	61·0	20·5	37·0
Length of fossa	57·0	19·5	37·0

The fossil bone is relatively stouter than the femur of Sarcophilus, and slenderer than that of Phascolomys; its proximal end is narrower than in either of these; its distal end (imperfect) may be narrower than in Phascolomys, and is broader than in Sarcophilus; its fossa is shorter than in Phascolomys, but longer than in Sarcophilus.

Recapitulating the more salient points of comparison, we find that the fossil resembles the femur of the carnivore in the shortness and direction of the lesser trochanterian ridge, in the obliquity of the post-trochanterian fossa, in the shape of the head, in that of the shaft anteriorly, and generally of the whole distal extremity. To this we may add that the backward curvature of the shaft is found in the allied genus Dasyurus. On the other hand, it resembles the corresponding bone in Phascolomys in the shape of the great trochanter exteriorly, in the prominence of the lesser trochanter, in the insertion of the ligamentum teres in the depth of the neck between the great trochanter and the head, and in the turgidity of the space between the fossa and the head. In brief, its proximal extremity, with prevailing characters of its own, has more of Phascolomys than of Sarcophilus in its composition, while its shaft and distal end show relation almost exclusively (as between these two) to Sarcophilus. But, withal, there are features of Macropus not to be overlooked; the angle of articulation, the shape anteriorly and length of the outer condyle, the tumid quadratus insertion, and the extracondylar groove.

We may sum up the whole by saying that sarcophiline affinities are dominant, phascolomine subordinate, macropine concomitant.

There is but one post-tertiary mammal at present known, to which, if carnivorous, such a femur could have belonged, a statement which, if true, raises a provisional assumption that it did belong to the animal in question, that is, Thylacoleo. The latter "if" is baseless to any one recalling mentally the several mammals discovered in the drift. That there may be another undiscovered, which will eventually put forward a better claim to ownership, goes without saying; but if we can connect the unknown with the known, it is our duty to do so. The former "if" cannot be quite so curtly dismissed, since the carnivority of Thylacoleo is (or has been) denied. Whatever arguments have been used against it, they seem, in the judgment of the writer, to be more than counterpoised by the simple fact that the animal had no efficient molars—a pair of shears on each side of the head, and practically no grinders, is hardly the equipment of a herbivorous animal, dependent for its existence on the thorough mastication and salivation of the grass, leaves, twigs, or roots which it crops or gnaws. On the other hand, grinders are not necessary to the absolute carnivore, whose food requires but the scantiest preparation for the solvent action of the digestive organs. The controversy is not, of course, affected by the present fossil, for it is only they who believe in the carnivorous habits of the "Marsupial Lion" who may be asked to admit it as confirmatory evidence—only they can grant that it could belong to Thylacoleo. At the same time, their opponents may fairly be invited to consider whether the future discovery of the carnivore to which this femur belonged, or the carnivority of the beast to which, as a carnivore, it might have belonged, is the more probable. Always supposing Thylacoleo to have been a carnivore, the reasons for putting forward the present fossil as its femur are, its suitable size and decidedly carnivorous affinities. The most threatening objection to such determination seems to be that the dentition of Thylacoleo is highly specialised, while the supposed femur is so generalised as to commingle the characters of at least three distinct families. But if Thylacoleo be, as it is held to be, a survival of the Plagiaulacidæ, the difficulty is minimised; we can understand the retention of the characters of the more generalised stock in the limb-bone concomitantly with a modification of the old specialisation of the teeth for the particular needs of the survivor.

Accepting it then (provisionally) as the femur of Thylacoleo, we derive from it a better idea of that animal than the teeth alone can give us. In the wombat and Tasmanian devil, both short-headed animals like Thylacoleo, the length of the femur is one-fifth less than that of the cranium—in Thylacoleo it is one-fifteenth greater. In accordance, therefore, with the other indications of its saltatory, or at least subsaltatory, mode of progression, it appears to have had the hind limb relatively elongated. From its size (greater than that of a full-grown kangaroo) we can hardly suppose it to have been of arboreal or fossorial habits. We may therefore conceive it, so far, as a saltigrade carnivore, or rather ossivore, with a relatively large and short head, and presumedly short feet, armed with prehensile claws. Such an animal may not have been as fell a destroyer as its name implies, or even as were its smaller contemporaries, Thylacinus and Sarcophilus, but its functions, though restricted to clearing away the dead and dying from amongst the living, were no less useful. Poetry must reluctantly give place to lowlier prose.

ON THE MINERAL RESOURCES OF KILKIVAN, WIDE BAY, AND ON THE RECENT DISCOVERY OF COBALT ORE IN THAT DISTRICT;

BY

W. FRYAR, Esq., Government Inspector of Mines.

(Read on the 6th August.)

THE metal cobalt is scarcely known to Queenslanders as a metal. We have all seen it or heard of it as a pigment, and have witnessed its effects in the hands of the artist and painter, in the colouring of porcelain and other earthenware, and perhaps more frequently in the varied shades of colour infused into glass. But in the normal condition of a metallic ore it has not up to the present time enriched the colony; for, although small quantities, traces, so to speak, have been found in some ores, it does not appear to have occurred, even to the sanguine mind of the prospector or speculator, that, in any case, there has been sufficient found to give so much as an appreciable addition to the value, estimated on other considerations, of the discovery.

The neighbourhood of Kilkivan, however, adds to its already varied laurels in the production of minerals, by presenting a possession unique, not only for Queensland, but so far as the entire Australian continent is concerned, and probably in some essential particulars unsurpassed anywhere. It may be mentioned that the immediate locality has been found to be rich in nearly all the precious and useful metals. The gold of the "Rise and Shine," the "Long Tunnel," the "Black Snake," and other lines of reef at various divergent points, has from time to time aroused the energy and raised the hope of the prospector, and its discovery stimulated the enterprise of the hardy miner, attracted the attention of the investor, and, in many cases, excited the cupidity of the speculator. Gold has, however, been obtained both from the alluvium and quartz reefs of the neighbourhood, and occasionally, as at "Black Snake," in rich patches, where, it is said, on the prospectors turning over a log, three black snakes were disturbed from their lair, and some pounds weight of gold exposed to view, which fortunate circumstance originated the gold and other mining enterprise of the neighbourhood, and gave it the name which, under any other circumstances, would not have conveyed any very pleasurable sensations, nor have had a very welcome reception by the diggers or any other class of bushmen.

Silver has also been found in the neighbourhood; sometimes associated with gold, sometimes with copper and other minerals, and occasionally in thin lodes of galena, which, with the lead and sulphur, generally carries a small percentage of silver. The silver, however, constitutes the most valuable and only product likely to make galena lodes worth working, under the peculiar conditions of labour and carriage attendant on the utilization of minerals in the remote and hilly districts outside the general line of railway communication; although the time is not far distant when the township of Kilkivan will enjoy the benefit of railway connection with the rest of the colony, as it is now blessed with telegraphic, when it is to be hoped that great impetus will thereby be given to the prosecution of an industry in which the district gives abundant promise.

In addition to gold, silver, and lead, copper may be incidentally mentioned, and to win this a considerable amount of work was done in erecting furnaces, sinking shafts, &c., but, unfortunately for the district and the colony, the difficulties of labour and transit, and the low price of the metal, effectually prevent the prosecution of such an enterprise at present.

Touching another of the metallic ores found in the neighbourhood, a much more hopeful and promising condition of things appears to exist. Some years ago certain veins of cinnabar were discovered, and for some little time worked with the most primitive appliances, and, as is usual on new mining fields, under very great disadvantages. With the assistance of an old oil-drum, for a retort, however, as much as 2½ per cent. of mercury was, I am informed, obtained from the ore. Now, when it is understood that one per cent. is nearly equal in value to 1 oz. of gold per ton of stone, and the difficulty and cost of extraction very much less than in the case of gold from auriferous quartz, it will be seen that with any reasonable quantity of ore there should be no difficulty in working these mines at a handsome profit. Indeed the British public have apparently arrived at this same conclusion, for we find that a company, with a capital of £400,000, has been formed in London to work these mines, and, by recent reports, a manager, with some of the necessary plant and appliances, has already arrived and operations will shortly be, if they have not already been, commenced.

Bismuth and zinc ores have also been found in small quantities in the neighbourhood, but the ore most recently brought under notice is a compound of cobalt nickel and manganese; all of value in the arts and manufactures of the world, although the last mentioned has been found in quantity at Gladstone and has not been worth working on its own account. Whilst, however, under the peculiar circumstances of the colony, it may be valueless when found unassociated with more valuable minerals and perhaps in a refractory state, that is no reason why, when obtained as a residual or by-product in the extraction of such minerals, it may not be a very considerable element in the gross returns of the undertaking.

Touching the value of the other constituents mentioned, there can be no question, whilst the minor accompaniments, such as arsenic and sulphur, may or may not be turned to account.

The reef or lode of this ore now being opened is situated on one of the spurs near the heads of Wide Bay Creek, and between the tributaries of that watercourse known as Fat Hen Creek and Copper Mine Creek. This spur slopes away from the place where the mine has been opened in a northerly direction, and is probably 1,000 to 1,200 feet above the valley and may be nearly 2,000 feet above sea level, although having been unaware, when leaving Brisbane, that I would be in that or any similar locality, I was not provided with an aneroid, and consequently speak from very imperfect data. The crown of the hill known as Mount Clara is a little to the south of the mine, and the outcrop of the reef runs along the eastern slope not far from the top and almost in a true north direction. Immediately beneath the opening the reef measures 21 feet 8 inches in thickness, dipping heavily to the west. The tunnel which has been driven has been begun on the top of the reef in a partially decomposed very soft serpentine rock, and dips two in three, *i.e.,* at an angle of about 34 degrees. The top of the reef is not closely followed, however, but is evidently lost after going a few feet, the rope wearing a projection of it to a fine polish of a beautiful blue colour and metallic lustre. This is 10 or 12 feet in from the outcrop; but at 12 yards in, an offshoot, several feet in thickness, is cut, and at 18 yards another such offshoot is reached. At 28 yards, driving has been stopped in the westerly direction, and a backset begun in a south-easterly one at an angle dipping very little from the horizontal, and in this excavation the two offshoots mentioned above are cut through; whilst at 12 yards the main lode, or what appears to be the main lode, is intersected and carries very good mineral. (A sample of this, broken off at the face, was shown at the meeting.)

It must not be supposed, however, that the whole 21 feet of reef is constituted on a par with this particular sample; it would be contrary to the known composition of lodes generally, and especially those of great thickness, which, though carrying valuable, precious, or useful ores of metals, these are rarely the unaccompanied occupants of them. The other chief components, however, being of commercial value, particularly the nickel, this thickness will not be so much of a bar to profitable working as it must be in cases where the "gangue" is valueless. And when it is remembered that the veins of cobalt ore hitherto discovered and worked are very thin, and that the supply being limited there has been no inducement to find out other applications for it in the arts, it may readily be surmised that the discovery is expected to effect a very considerable change, both in the supply of raw material and in the application of the purified article to the various arts of civilised life. The difficulty of extraction, however, may be a bar to the application of scientific chemistry on the spot, and the refractory ore may even require to be sent abroad for manipulation, but with a railway to the mines and with this unusually large supply it may fairly be hoped that we have here another pledge of the future prosperity of the mining industry in a district which has already given promise of reward to legitimate enterprise in various classes of mining.

I have found great difficulty in obtaining any statistical information touching the quantity of cobalt used, or its value either in the raw state as ore, or at any of the stages through which it may have to pass in process of extraction and purification, and the value of the product of a chemical operation is often only a poor guide to an estimate of the value of the raw material employed. Consequently little can be known here of the actual value of the ore in the mine. It may be safely assumed, however, that whether operations be confined to mining the ore and shipping it, for sale abroad, or it be chemically reduced on the spot; the discovery and working of another mineral not hitherto produced by the colony, and one which is found richer in metal and in larger quantities of ore than is usual, is a not unimportant step in our onward progress; for on the percentage composition of the ore, the quantity of ore in the vein, the thickness of the lode, and all the other incidentals of locality, cost of labour, carriage, and the like, the profitable working of a mine principally depends.

The statistics of quantity and value which I have seen, in most cases, put the ore as of nickel and cobalt. In the United States of America in 1882, the value was £3000, but the quantity is not stated. In Germany in 1881, 191 tons value £13,005, equal to £68 per ton. In Spain in 1882, 40 tons value £1046, equal to £26 per ton. In Norway in 1878, 108 tons value £11,112, or £103 per ton. Sweden produced an average of 153 tons per annum during 10 years, but the value is not stated. The value of ore of nickel and cobalt is given variously at from £40 down to £4, according to quality and locality.

There is no definite information obtainable touching the value of any specific quality of ore with which to test the value of the ore now mentioned as having been recently discovered.

These points are referred to because, although not new or scientific, and therefore perhaps not quite within the scope of the Society, they very materially affect the important consideration of the value of the discovery to the colony.

Touching the uses and qualities of cobalt, Greenwood says—"Cobalt is chiefly used in the arts in the form of oxide, silicate, or other chemical combinations constituting the bases of a large number of pigments and material largely employed for imparting a blue colour to glass, enamels, &c." The specific gravity of the metal is given as 8·957; it is highly magnetic and of great tenacity, a wire of cobalt supporting twice the weight required to break a similar wire of iron; it is considered the most malleable of metals, and it is not sensibly oxidised by exposure at ordinary temperatures.

The following is an analysis of the ore here referred to, presumably by Mr. K. T. Staiger, appended to an exhibit in the Queensland Museum:—

Cobalt	22·207	per cent.
Nickel	3·510	,,
Iron	29·130	,,
Manganese	2·360	,,
Copper	0·103	,,

Cobalt glance and cobalt pyrites have been found richer than this analysis shows, but Overman, who gives the analyses, does not say where nor in what quantity these particular ores occur, but it is probable as accidental minerals in connection with others, and not in sufficient quantity to be worked for their own intrinsic value. The general value of the ores of commerce appears to be much less, probably not more than from 2 to 10 per cent., and consequently the Kilkivan ore, with 22 per cent. cobalt, should be very valuable.

This is a matter of some public importance apart from and in addition to the mere question of the profitable occupation of miners.

A branch railway from the Maryborough-Gympie line is now in course of construction to Kilkivan, and grave doubts have been entertained touching the prospect of sufficient traffic to justify such an undertaking. There is no other industrial enterprise, however, into which colonists can enter there which is so likely to give traffic to a railway as that of mining, whether it be of cobalt and nickel ores, of cinnabar, galena, copper, or gold, all of which, as we have seen, are found in greater or less abundance in the neighbourhood.

Coal, it is admitted, yields more work for railways, but could scarely be mentioned in connection with the metallic ores, but the coal of Miva and Munna Creeks, near the Kilkivan line now in course of construction, has long been known as a prospective, if not a present, source of wealth, and very excellent specimens were shown me by the contractors for the line, Messrs. M'Dermott and Owens, who have in a praiseworthy manner taken special note of the mineralogy of the district which this line is traversing.

The branch line is now opened to the Mary River, a distance of four miles from the junction. A bridge of very considerable dimensions is erected across the river suitable, not only for the railway, but for ordinary vehicular, horse, and foot traffic. The rails are laid a distance of 12 miles further still, and the contractors' engine travels that distance. In the cuttings near the river the aqueous deposits of the coal measures are visible, but further on a varied and interesting exhibition of volcanic and plutonic phenomena is seen exposed, particularly in the sidling cuttings on Bong Millerer Creek.

The line may thus be said to be completed as far as Woolgar, and its construction is well advanced, a distance of 10 miles further, towards Kilkivan, which will be the terminus of the line, so far as at present arranged. The distance hence to the newly-opened cobalt mine is about 10 miles by the nearest practicable route, the direct distance being probably from five to six miles. The Mount Corra and Black Snake are in the immediate neighbourhood ; also, if a somewhat more circuitous route be taken, the cinnabar mines would be included within the operations of such means of communication.

As this would probably, however, be a question for the mine owners, we can only conclude with a hope that the wealth of minerals proved to exist in that neighbourhood may, within a reasonable period of time, add to the realised wealth of the colony and assist in relieving the present somewhat depressed condition of mining in the neighbouring gold mining township of Gympie, which, in its early days, did such good service in lifting the colony out of the slough of despond engendered by the depression of 1866, severely felt and long remembered by many of the residents of the city of Brisbane in the earlier days of our now prosperous colony.

NEST AND EGGS OF THE JABIRU;

BY

W. T. WHITE, Esq.

WITH AN

INTRODUCTORY NOTE;

BY

HENRY TRYON.

(Read on 6th August, 1886.)

OUR Australian Jabiru, though never met with in Victoria or South Australia, is generally distributed throughout the remainder of the continent, being for the most part restricted to the coast districts, and seldom found more than 300 miles inland. It is nowhere plentiful, though it may be occasionally seen in some numbers about such estuarine waters as those of the Herbert River. Difficult to approach, its large size and conspicuously handsome appearance render it a favourite mark for the sportsman's rifle, so much so that already it is a bird unheard of in the neighbourhood of settled districts. That the Jabiru is doomed to extinction, unless steps are taken to prohibit its slaughter, there can be little doubt; the description, however, of its habits and representation of its appearance given by the Nestor of Australian naturalists, Dr. G. Bennett, in his "Wanderings," not to speak of the accounts of less popular writers, will help to perpetuate its memory. Its history, however, is not yet completely written, since its nidification and the character of its eggs are subjects which do not appear to have been dealt with by those who have especially written on these features in Australian bird-life, such as Gould, Ramsay, Campbell, and others.

The Australian Jabiru, until recently, has been considered, by writers other than Gould, to be a distinct species from Xenorhynchus asiaticus, *Lath.*, the Indian Jabiru. Salvadori, however, points out * that this is not the case, and further remarks that naturalists in thinking so have been misled by the description of the bird as given by Gould, in which that writer states that the feathers of the back are black, instead of white, as they undoubtedly are, having wrongly regarded the scapularies as dorsal plumes. Did this character exist, it were correct to consider the Australian species as being distinct from the Indian, and not identical with it, as Gould appears to have done.

Students of Australian ornithology, in the light only of the ordinary text-books on the subject, and unfamiliar with the views of Salvadori, will, however, take time to adopt his correction, and will welcome the following notes as helping to complete the history of our Jabiru, rather than appropriate for this purpose what already does so, viz., that which has been written from a similar point of view concerning the Indian bird.

There are yet other considerations why it is desirable to make this record.

As Salvadori also has pointed out, Xenorhynchus asiaticus, *Lath.* (for thus in future must we designate the Australian Jabiru), forms two colonies, which are for the most part distinct, one colony (with which we are immediately concerned) comprising Australia, and extending to the islands of Torres Straits and to the south-east of New Guinea, the other colony comprising India, Arracan, Tenasserim, and Ceylon. It would be interesting, then, to establish the fact whether or not the birds which are restricted to these separate regions present differences of habit, which would probably be the case if this remarkable fact in geographical distribution were of very long stand-

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* Ornithologia della Papuasia e delle Molluche, Pt. 3, p. 378. Torino, 1882.

ing, even though from the point of view of their organization the birds were identical, and what habit more susceptible of comparison than that concerning incubation.

We must also bear in mind the difficulty of access to any published description relating to the nidification and eggs of the Indian Jabiru. Not to overlook Latham's meagre notice,* the only detailed description existing is that given by Hume in his "Nests and Eggs of Indian Birds."†—a work scarcely to be met with in any library in Australia.

[The nest of the Jabiru bears great resemblance to the nest of the eagle *(Aquilla audax)* in both size and appearance, but it is always so situated that there is nothing above it. The bird selects a lofty tree, generally one with the top broken off, close to the margin of a swamp or lagoon, and on the highest point of it builds a pile of sticks about three feet in depth and four in diameter; a thin layer of grass or rushes is placed upon the sticks, and upon this surface, which is almost perfectly flat, the eggs (two in number) are laid. I am of opinion that the Jabiru, like the Native Companion, does not lay more than two eggs,‡ and like most of the waders breeds during the rainy season.

I am unable to say what the period of incubation is, but both sexes share in the process.

The eggs were obtained in the neighbourhood of Ingham, on the Herbert River, in the month of March last year. The nest from which they were taken was built of sticks in the very top of a tall tree growing near a marsh.—W.T.W.]

The following is Hume's description of the eggs of the Indian bird :—

§ "In shape they are typically broad ovals, compressed towards one end, so as to have a slightly pyriform tendency; elongated ovals and almost spherical varieties are not uncommon. The eggs are dull and almost glossless, but though the texture is somewhat

* "General History of Birds," Vol. IX., p. 17. Winchester, 1824.

† *Op. cit.,* Vol. III., p. 607. Calcutta, 1875.

‡ Concerning the number of eggs which the clutch of the Indian bird contains, Mr. Allan Hume remarks—"Four is certainly the regular complement of eggs, and one of the four is often bad, so that they much more often rear three than four young ones." (*Op. cit.* p. 607).—H.T.

§ "Nest and Eggs of Indian Birds."—Rough draft. Part —, p. 60. Calcutta, 1873.

coarse, they are fairly smooth to the touch; when fresh they are nearly pure white, with only the faintest possible bluish-grey tinge, but after being a few days in the nest they become soiled and tanned and assume that dingy yellowish-white or pale yellowish-brown tint so characteristic of storks' eggs. In length the eggs vary from 2·65″ to 3·13″, and in breadth from 1·98″ to 2·3″; but the average of 45 eggs is 2·91″ by 2·12″."

The two Ingham specimens may be fairly considered to be included in the above definition of Hume. No 1 measures 2.926″ (75 mm.) in length and 2·106″ (54 mm.) in breadth, and is stained to a slightly darker colour than No. 2. The latter measures 2·974″ (76 mm.) in length and 2·184″ (56 mm.) in breadth, and is also more nearly elliptical than No. 1. Both eggs have their surfaces much smoother about the middle region than at the poles.

ON FISH ACCLIMATIZATION IN QUEENSLAND;

BY

D. O'CONNOR, Esq.

(Read on 6th August, 1886.)

I HAVE been requested to give you an account of a recent attempt to acclimatize English fish in our waters.

Fish acclimatization, although considered in every part of the civilised world a subject of importance, has hitherto received little or no attention in Queensland, except from the gentlemen whose names are mentioned in this communication. At the request of Mr. R. B. Sheridan, M.L.A., who obtained the necessary funds, and kindly assisted by Sir Samuel Griffith, who gave me an official letter to the Chief Secretary of Victoria, I proceeded to Ballarat a short time ago, and through the generosity of the Mayor and the Acclimatization Society of Ballarat, received about a hundred small fish which were placed in six tins of the approved pattern, that is, a plain cylinder of 14 inches in diameter and 16 inches in height, in fact, a large camp kettle, the cover, which is seldom used, being flat and perforated with numerous holes. The tins were about one-third filled with water from the Lake Wendouree, and the fish were put in them late on Friday afternoon, 16th July; they were the next morning taken by train to Melbourne, a distance of a hundred miles, and carried direct on board the s.s. "Rockton."

This steamer left Melbourne at mid-day. The fish had stood the journey from Ballarat to Melbourne well, and appeared quite lively and healthy. The first casualty after leaving this port occurred shortly before midnight, and by sunset the next day fifteen trout and one perch had died; during the following night one trout, and on Monday one trout and ten tench died. Between Sydney and Brisbane there was only one death, a tench; two tench also died on the road to the Gold Creek reservoir, into which, shortly before noon on Friday, 23rd July, Mr. R. B. Sheridan, Mr. E. Kelk, and I had the pleasure of liberating thirty-six perch, fifteen trout, three carp, and three tench. They all appeared in good condition when turned out. The water was changed in Sydney by the Acclimatization Society's Inspector, whose services were kindly placed at my disposal by Dr. Cox, an enthusiastic fish acclimatizer, I have only to add that the fish were not fed during transit, and the water was ærated by means of a garden syringe, with a fine rose attachment, every two or three hours day and night.

In view of the great results achieved in Ballarat, where, from a stock of six perch, Lake Wendouree, and other waters now swarm with these fish, I think we may encourage the hope that our late experiment may prove successful.

ON THE OCCURRENCE OF CHANOS SALMONEUS IN MORETON BAY;

BY

D. O'CONNOR, Esq.

(Read on 6th August, 1886.)

RECENTLY some fishermen netted in the south part of Moreton Bay four fish which were quite new to them.

The Museum fortunately secured one of these, which on examination proved to be the celebrated Chanos salmoneus of the Indo-Pacific Ocean. This fish has occasionally been met with at Port Jackson, and is included in the lists of New South Wales fishes by Count Castelnau, Messrs. MacLeay, Tenison-Woods, Ogilby, and others. Mr. Tenison-Woods in his chapter on "Fish Acclimatization and Pisciculture," quotes R.R.C. as follows:—"One other fish we would suggest to those who are disposed to introduce and acclimatize fishes of a very superior quality. The Chanos salmoneus is of the herring family, of large size (two feet long), extreme beauty and metallic brilliancy, and of the most exquisite flavour. It is found, though rarely, in these latitudes, its true habitat being in warmer seas. This fish is cultivated and kept in tanks in Southern India and Malacca, where it is highly prized and regarded as an expensive luxury."

Mr. MacLeay says—"If a little of the enterprise exhibited in the efforts that have been made to introduce the salmon into our rivers were expended upon the cultivation of this fish in our coast rivers north of the Clarence, the result, I venture to say, would be more satisfactory."

I have repeatedly heard of the existence of a fish on our north-eastern coast, whose description accorded strictly with that of Chanos salmoneus, though my informants invariably called it Barramundi. This name is applied to several other Queensland fishes of widely different kinds, but always to fish which attain large dimensions.

In Fiji Chanos salmoneus is found in fresh water, and although it is not said whether, in its domesticated state, in India it lives in salt water or fresh, we may perhaps reasonably conclude that, like the Gourami, it inhabits fresh water there also.

The range of Chanos salmoneus appears to be very great; it is to be found in the Red Sea, where it is known as "Auged," a name signifying grapes, raisins, or wine. In India it is known as the "Milk Fish." It is also found at Zanzibar, the Seychelles, Ceylon, Penang, Formosa, Cape York, Port Essington, and numerous other places.

Its clipper-like form and powerful fins evidence great speed, and this may in some degree account for its wide-spread habitat. For its safety, also, speed appears indispensible, as it possesses no teeth or other weapon of defence.

In a fresh state, the eye and post-orbital space is covered by a very thick and transparent kind of adipose tissue. There is also a remarkable feature presented by the little horny plates on either side of the profoundly lobed tail, and at the base of each of the other fins.

Dr. Gunther states that Chanos salmoneus attains a length of four feet, and that its flesh is highly esteemed.

EXHIBITS.

The following objects were exhibited:—The skull and femur of Thylacoleo, from the Darling Downs; cobalt ore from Kilkivan; the Jabiru and its eggs; and the fish Chanos salmoneus, *Forsk.*, Osphronemus olfax (the *gourami*), Osteoglossum leichhardti (the *Barramundi* of the Dawson River), in illustration of the several papers read. Mr. C. W. De Vis also drew attention to a fine example of Patœcus fronto, a curious Blenny which had been found on the main beach opposite Southport; and Mr. J. Falconer, C.E., exhibited cores obtained in boring, as illustrating the occurrence of an apparently valuable class of coal from a new locality, in the Moreton Bay District, for that mineral. There was also laid on the table, on behalf of Mr. J. Thorpe, a chart showing the record of a self-registering aneroid barometer, made at Brisbane during the month of July, with indications of the prevailing barometric conditions in the southern colonies during the same time.

FRIDAY, OCTOBER 8TH, 1886.

L. A. BERNAYS, ESQ., F.L.S., IN THE CHAIR.

FIELD NATURALISTS' SECTION.

THE Hon. Secretary, Mr. H. Tryon, having alluded to the recent formation of a Field Naturalists' Club, as a section of the Society, stated that the first excursion of the Club would be held on Saturday, 9th October. Members to meet at Bowen Park at 3 p.m.

NEW MEMBERS.

W. F. Taylor, M.D., Mr. T. Waram, Mr. L. Corrie and Mr. F. Corrie.

DONATIONS.

"Results of Rain and River Observations, made in New South Wales during 1885;" "Local Variation and Vibrations of the Earth's Surface," Roy. Soc., N.S.W., 1st July, 1885; and "Anniversary Address," Roy. Soc., N.S.W., 6th May, 1885, by H. C. Russell, B.A., F.R.A.S., etc. From the Author.

"Royal Commission on Vegetable Products: Second Progress Report." Victoria, by Authority, 1886. From L. A. Bernays, Esq., F.L.S.

"Victorian Naturalist," Vol. III., Nos. 4 and 5. Melbourne, August and September, 1886; and "Sixth Annual Report, 1885-6." From the Field Naturalist Club of Victoria.

"Journal of the Bombay Natural History Society," Vol. I., No. 3. Bombay, July, 1886. From the Society.

"Abstract of Proceedings." Aug. 10 and Sep. 13, 1886. From the Royal Society of Tasmania.

"Donations to the Bodleian Library in 1885." Oxford, 1886. From the Bodleian Library.

"Atti della Società Toscana di Scienze Naturali," Processi Verbali, Vol. V. May 2nd, 1885. From the Society.

"Proceedings of the Canadian Institute," 3rd Series, Vol. III., Fasc, No. 4. Toronto, 1886. From the Institute.

"Journal of the Asiatic Society of Bengal," Vol. LV., Pts. 1 and 2. Calcutta, 1886. From the Society.

"Proces Verbaux des Séances de la Société Royale Malacologique de Belgique," Tom. XIV., pp. 1-80. Bruxelles, 1885. From the Society.

"Proceedings of the Linnean Society of N.S.W." 2nd Series, Vol. I., Pt. 2; and "Catalogue of the Library." Sydney, 1886. From the Society.

"Journal of Conchology," Vol. V., No. 3. Leeds, July, 1886. From the Conchological Society of Great Britain.

"Russkago Geographeskago Obshtchestva," Tom. XXII., Pt. 2. St. Petersburg, 1886. From La Société Imperiale Russe de Geographie.

"Australian Museum: Report of Trustees for 1885, with Supplement." By Authority: Sydney, 1885-6. From the Australian Museum.

"Notes on some Australian Tribes," by Edward Palmer, M.L.A. *Journ. Anthrop. Inst.*, Febry., 1884. From the Author.

"Records of the Geological Survey of India," Vol. XIX., Pt. 3. Calcutta, 1886. From the Director.

"Bulletin of the American Geographical Society," 1882. No. 6. New York, n.d. From the Society.

"Proceedings of the American Academy of Arts and Sciences," Vol. XXI., Pt., 1. Boston, 1885. From the Academy.

"Mittheilungen der Anthropologischen Gescellschaft, in Wein," Band, XV., Heft. 3. Vienna, 1885. From the Society.

"Australian Irrigationist," No. 26. Melbourne, 1886. From the Editor.

The following Paper was read:—

INDELIBLE WRITING INKS;

BY

H. W. FOX, Esq.

(Read on 8th October, 1886.)

THE object of this paper is to draw attention to a subject which is well worthy the consideration of the Government and the public. Although rapid strides have been made in inventions and improvements of all kinds, especially in machinery, the very urgent need for an improved quality of writing ink seems to have been overlooked. Any person having to search old documents for information must have observed the difficulty there is in deciphering some of the very old ones, the ink having faded to such a degree as to make them almost illegible; even now, deeds may be seen which were prepared in this colony in former days on which the Governor's signature has almost disappeared. If such be the case in so short a period of time, what will be the result in the course of centuries? Simply, many valuable documents will then be sheets of almost blank paper or parchment, probably having yellow stains, but perfectly illegible. It must be admitted that the Chinese are in advance of us in this respect. They have long had the credit of being excellent colour manufacturers, and a carbon ink has been used by them from time immemorial. A similar ink must have been used by the ancient monks in Europe for making copies of the Scriptures, which now retain their blackness. If they had been written with ink like that now in use, which is simply a stain containing no carbon, they would in all probability have faded out centuries ago.

Let us now consider the composition of our modern and ancient inks

Mr. Underwood, an ink manufacturer, who read a paper upon this subject before the Society of Arts in 1857, thinks that some old inks were merely carbon pigments like the Indian Ink of the present day, while other kinds were veritable dyes of iron and acids (true chemical compounds), with the addition of a great deal of carbon.

The usual constituents of black writing ink are galls, sulphate of iron, and gum-arabic. In place of the galls, wattle and gum barks would answer the purpose. The gum is used for the purpose of holding the colouring matter in suspension, and to prevent the mixture from becoming too fluid.

Stephens's blue-black ink, which in a short time after writing becomes a very deep black, is the most used in the present day. It consists of gallo-tanate of iron dissolved in sulphate of indigo, the indigo giving it the blue appearance. This ink appears blue when first put on the paper, but after a time takes up oxygen from the atmosphere, and thus becomes more black and less soluble. By adding sugar and other substances to this ink, it is used for copying purposes, being thereby rendered more soluble, but is then far less permanent, as I have had the opportunity of proving by examining letters in copying books, kindly shown me by the Hon. A. C. Gregory, C.M.G., F.R.G.S., some of which, having been copied in 1865, are barely legible, although he has tried to renovate them by several chemical processes. This fact seems to thoroughly prove the importance of devising another mode of copying important documents.

Blue inks are generally made of Prussian blue. Stephens's unchangeable blue ink is made by dissolving this blue in an aqueous solution of oxalic acid. Ink made from this blue, although not affected much by the physical causes which so injure black ink, will, when exposed to a strong light, fade; but, on being again placed in a dark place, resume nearly its original colour.

Red inks are made of logwood or cochineal and chloride of tin. Alum used instead of this chloride, makes the ink more of the colour of lake.

All other fancy coloured inks are usually made of aniline dyes, and are extremely evanescent.

The following black ink has been recommended as a very permanent one, and not obtainable by the interaction of chemical substances, viz., twenty-four pounds of Frankfurt black (which is said to be a carbon obtained from grape and vine lees, peach kernels, and bone shavings) ground with twenty pounds of gum-arabic to sixty gallons of water, adding four pounds of oxalic acid and a solution of cochineal, sulphate of indigo, or Prussian blue. These colours are used to produce the required tint.

With reference to Indian ink, of which carbon is the chief constituent, it may be well to notice some of its principal qualities. It is not generally known, perhaps, by the public, that it is the best known marking ink for linen and other fabrics, not being liable to turn brown or yellow, as all other marking inks seem to do. The draftsmen in the Surveyor-General's office here have had long experience on this point, for it has been their habit to mark the towels used there with this ink. Now, of course, such articles require and get much washing, thereby giving the ink a good crucial test, which it has stood remarkably well, not becoming obliterated or changed in colour, but turning greyer on account of some of the particles of carbon being washed away.

The scientific reason of this ink standing so well is that it being composed of carbon and gelatine, the gelatine entering into the texture of the fabric, becomes insoluble in water by admixture with the tannin still contained in the fabric, quite sufficient remaining to produce that effect; the gelatine thus becoming insoluble retains particles of the unalterable carbon, which, consequently, remain in the texture of the cotton or linen fabric till it is worn out by usage; no amount of washing being sufficient to eradicate them. Such is also the case when used on paper which is made of such fabrics.

It is well known by experienced draftsmen, that if a drawing made in Indian ink is often washed with a sponge and water, and a portion of the upper surface of the ink removed, still leaving sufficient in the pores of the paper for the drawing to be still dark, this removal of the free ink allows washes of colours to be made over the drawing without smearing. Again, if it is desirable to varnish a strong, black Indian ink drawing, *the ink having been prepared for the purpose*, a gelatine size can be brushed over the surface without making the ink run, such size being necessary before varnishing, as the oil in the varnish would penetrate the pores of the paper, causing it to become semi-transparent, which is very undesirable, as a dark yellowish tint is thereby occasioned.

If the drawing has been made with ordinary Indian ink, the gelatine size would dissolve the upper stratum, the tannin in the paper being insufficient to harden the whole of the ink, but by mixing the ink with certain chemical solutions this is obviated.

Now, why not use such an ink for ordinary writing? It runs easily enough from the pen, and the only trouble would be the mixing before using. It might necessitate the keeping of a small bottle of the chemical solution to mix with the ink (a number of chemicals may be used for this purpose), but no doubt a method would soon be discovered for preparing it mixed and bottled ready for use, the same as our ordinary inks. This seems to be quite feasible, and, if not, would it not be preferable to spend a few minutes in preparing the ink before writing valuable documents which are intended to be handed down to future generations, instead of writing with an ink which is so fugacious, as the modern ink undoubtedly is? It seems surprising that this matter has been so long neglected by our *savants*.

The more compound the inks are, the more likely are they to fade, as is proved by the copying inks, which fade far sooner than those composed of fewer elements; the extraneous substances introduced, such as sugar, gums, &c., causing a greater chemical action to take place.

To test inks as to their permanency, drop a little hydrochloric acid upon them. If they remain black, you may consider they are not liable to fade. The ordinary blue-black ink will lose its blackness in a very short time, still retaining a little of the blue colour; red ink will fade entirely away. The well known experiment may be tried of sprinkling a few drops of the acid on a black cloth coat, which is dyed with a similar material to black ink; in a short time the spots will appear of a bright red colour. The black may be restored by applying a solution of sulphate of iron.

Although our written documents may fade entirely away in a comparatively short space of time, there will be a large proportion of our valuable literature preserved in the shape of books, thanks to our printing press, as the black printing ink used in printing is chiefly composed of a carbon pigment. But many of the colours now used in printing are evanescent, notably violets, carmines, lakes, most madders, and perhaps all aniline colours. Those more durable are ultramarine blue, greens, chrome yellows, brown and yellow ochres, Chinese vermillion, and rose madder, but none of these colours are so vivid as the aniline ones.

The subject of photographic prints may not be out of place here, as being somewhat connected with the subject of inks.

It is well known by many that the ordinary silver prints will gradually fade away. It may be well to state (for the benefit of the uninitiated) that the usual portrait and landscape photographs are printed on a paper previously coated with a solution of nitrate of silver, and the silver unacted on by the chemical rays of light, having been dissolved out by dipping in a solution of hyposulphate of soda. This soda is removed as nearly as can be by repeated washings of pure water, but it is practically impossible to destroy or eradicate every trace of the soda from the pores of the paper, and the small portion which remains will eventually have a chemical action on the silver of the print, causing it gradually to assume the form of sulphate of silver, which is a dirty yellow colour. You may have noticed on some old prints yellow spots; they are the result of the soda still retained in the pores of the paper. Again the atmosphere, especially a damp one, may contain sulphates, which attack more or less such a sensitive as silver, causing a deterioration in colour.

Nitrate of silver has been used with good permanent results on fabrics which have been kept in a very dry place, as in a dry atmosphere the sulphates are much more weak than in a damp one. And in such places as stone coffers in the centres of pyramids, dampness would be in the minimum. I have heard that the documents found in such places have been often written with the nitrate of silver.

The nitrate of silver being so evanescent on paper has caused photographers to tax their brains to find a suitable substitute, in which they have been eminently successful, using a carbon pigment instead of the silver, thereby defying (within certain limits) the ravages of time. A number of processes have been taken advantage of by some publishers of books for their illustration, but these cannot be brought into general use for portrait or landscape photography, as the prints could not be produced in small numbers at a cost suitable to the public, therefore the public must be contented as at present with ones that fade.

Reference might be made to several of these carbon processes, viz., the Heliotype, Woodburytype, Albertype, Phototype, Photogravure, Photolithographic, &c., all of which are permanent.

In conclusion, perhaps it may not be out of place to call the attention of those concerned to the fact, that voilet aniline ink, the most evanescent of all, is being used largely for stamping names, as signatures, or otherwise, in the Government departments, as well as by private firms; a fact which is much to be deplored. It is notably the case in the Registrar of Titles' Department, where a stamp is used for mortgages or new titles.

A discussion, in which the Chairman, and Messrs. J. Falconer, E. B. Lindon, L. J. Byrne, and H. Tryon took part, then ensued. Mr. L. A. Bernays dwelt on the importance of the subject, and suggested that the paper should be referred again to the Council with the view to its considering whether it was not justified in inviting the Government to enquire into a matter which, perhaps, had not previously claimed the latter's attention.

EXHIBITS.

Amongst the exhibits, Mr. J. Falconer, C.E., drew attention to some handsome specimens of auriferous galena, from the Allandale Silver Mine, near Mount Shamrock, and also to some ores from the Victoria Copper Mine, near Mount Perry.

FRIDAY, 3RD DECEMBER, 1886.

THE PRESIDENT, A. NORTON, ESQ., M.L.A., IN THE CHAIR.

NEW MEMBERS.

Mr. J. S. Cameron, Mrs. C. Coxen, Mr. C. R. Finlay, Mr. W. G. Grimes, Mr. H. Hockings, Mr. D. G. Hutton, Mr. A. H. Kemp, J. Lauterer, M.D., Mr. J. R. Sankey, and Mr. J. F. Shirley, B.Sc.

DONATIONS.

"Abstract of the Proceedings of the Royal Society of Tasmania, Sep. 13, 1886." From the Society.

"Report of the Board of Governors of the Public Library, etc., of South Australia, for 1885-6." Adelaide, 1886. From the General Director.

"Observations of the International Polar Expeditions, 1882-3 (Fort Rae)." London, 1886. From the Meteorological Office, London.

"Descriptions and Illustrations of Myoporinous Plants of Victoria." By Baron Ferd. von Müeller, K.C.M.G., etc., Government Botanist of Victoria. II. Lithograms. Melbourne, 1886. From the Author.

"Journal of the Straits Branch of the Royal Asiatic Society," No. 16, December, 1885; and "Notes and Queries," No. 3. Singapore, 1886. From the Society.

"The Australian Irrigationist," No. 27. Melbourne, October 28, 1886. From the Editor.

"Journal and Proceedings of the Royal Society of New South Wales," for 1885. Sydney, 1886. From the Society.

"Transactions of the Seismological Society of Japan," Vol. IX., parts 1 and 2. Yokohama, 1886. From the Society.

"The Victorian Naturalist," Vol. III., No. 6. Melbourne, October, 1886. From the Field Naturalists' Club of Victoria.

"Medical Press and Circular," Vol. XCIII., No. 2473. Dublin, 1886. From the Editor.

"History, Rules and Regulations, etc., of the Meteorological Society of Australasia." Adelaide, 1886. From the Society.

"Bulletin of the American Geographical Society," 1883, No. 7; and 1884, No. 5. New York, n.d. From the Society.

"Transactions of the Geological Society of Australasia," Vol. I., part 1. Melbourne, 1886. From the Society.

"Atti della Società Toscana di Scienze Naturali, Processi Verbali," Vol. V. Piza, July, 1886. From the Society.

"Proceedings of the Linnean Society of New South Wales," 2nd series, Vol. I., part 3. Sydney, November 3, 1886. From the Society.

"Annual Report of the Department of Mines, New South Wales." Sydney, 1877-1885, 9 vols. From the Director of the Geological Survey of N.S.W.

"Sydney University Calendar," 1886, and "Catalogue of the Books in the Library of the University of Sydney." Sydney, 1885. From the Registrar of the University.

"Revista de los Progresos Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid," Tomo XXI., Nos. 7, 8, 9; and Tomo XXII., No. 2. Madrid, 1886. From the Academy.

"Bericht über die Senckenbergische naturforschende Gesellschaft in Frankfurt am Main," 1886. F. a. M., 1886. From the Society.

"United States International Exhibition, 1876," Vols. X. and XI. "Executive Department," Vol. I. (War Department); ditto, Vol. II. (Navy, Treasury, Post Office, and Department of Agriculture). Washington, 1884. From the Smithsonian Institution.

"Transactions of the New York Academy of Sciences," Vol. III., pp. 201-328; Vol. III., 1883-4. New York, 1885; and Vol. V., Nos. 2-6. New York, 1886. From the Academy.

"Proceedings of the Academy of Natural Science of Philadelphia," part 1. Philadelphia, March, 1886. From the Academy.

"Bulletin of the Californian Academy of Sciences," Vol. I., Nos. 1-4, 1884-6. San Francisco, 1886. From the Academy.

"Transactions and Proceedings of the Botanical Society," Vol. XVI., part 2. Edinburgh, 1886. From the Society.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Mr. H. Tryon, the representative of the Society at the preliminary meeting recently held in Sydney, in connection with the projected Australasian Association for the Advancement of Science, read his report of the proceedings on that occasion.

After some reference, made by different members, to the little accomplished, in the direction of the formation of an Association, at this preliminary meeting, it was unanimously resolved that the report be received and printed, and that a vote of thanks be accorded to Mr. Tryon for the manner in which he had represented the Society.—[*Vid.* Appendix.]

The following notes were read:—

"FASCIATION IN BOUVARDIA TRIPHYLLA, *Salisb.*," by F. M. Bailey, F.L.S., Colonial Botanist.—Perhaps there is not another part of the globe where plant fasciation is more abundant than in Australia. The attention of the gardener is continually attracted to it, and in our shrubs one often meets with stems, and especially those of climbing plants, flattened out to several inches by this curious abnormal growth. But it is seldom, if we pass over the case of the garden cockscomb, that these forms add to the beauty of the flower or plant.

A very curious and beautiful form of fasciation has just now occurred in the garden of Mr. Thos. Burns, one of the Brisbane florists. One of the stems of a garden variety of Bouvardia triphylla, *Salisb.*, has flattened out about $\frac{1}{4}$in. wide, thin and prominently grooved. The leaves, instead of the usual three, are on this stem in close whorls of from 8 to 12; in form a little smaller but resembling the normal state. At each whorl of leaves is a whorl of over 22 flowers normal as to size, form, and colours. These whorls, near the extremity of the stem, are so close together as to form a large, dense corymb of flowers, but the most curious part of this abnormal growth is that the shoot terminates in one large single bloom, the calyx of which is flattened out to correspond with the stem; tube flabellate about 2 lines long, deeply corrugated; lobes about 40 lanceolate 3 lines long; corolla of normal colour companulate; tubes extending rather more than ½in. beyond the calyx-lobes, fringed by the numerous 40 to 50 rather curly lobes. Stamens, as many as corolla lobes, perfect normal, forming a close ring in the throat. Styles: one appearing to be normal, the others more or less adnate to each other in three bundles.

Bouvardia is a genus of Rubiaceæ, tribe Cinchenaæ. Its 20 to 30 known species are principally Mexican, and the rather numerous garden forms are great favourites with Australian florists.

"ON NATIVE ZINC IN QUEENSLAND," by E. B. Lindon, A.R.S.M., etc.—Professor J. W. Dana, in his "System of Mineralogy," edition 1883, says that native zinc is "reported by G. Ulrich as having been found in a geode in basalt near Melbourne, and that the piece weighed 4½ oz., was incrusted with smithsonite, aragonite, and some cobalt bloom." Native zinc was "also said to occur in the gold sands of the Mittamitta River, north of Melbourne, along with topaz, corundum, &c.; a single piece, according to L. Becker, having been found which contained traces of cadmium and other metals. (L. Becker, in Trans. Phil. Inst., Victoria, 1856, and Jahrb. Min., 1857, 312, 698; G. Ulrich, in B. H. Ztg., XVIII., 63). It should be stated that the zinc said to come from the Melbourne basalt was found by a quarryman and not by a scientific observer, and that therefore there may be an error with regard to its actually having been taken from the basalt." Professor Dana then makes the pertinent remark that "the existence of native zinc seems still to need confirmation."

From Vol. XI., p. 234 of 3rd series of the American Journal of Science, I take the following note:—"*On the occurrence of Native Zinc.* (Letter to one of the Editors).—Mr. W. D. Marks, of Chattanooga, Tennessee, announces the occurrence of fragments of metallic zinc in the soil along the course of a vein intersecting the blue limestone of Sand Mountain, in the north-eastern corner of Alabama. The circumstance is supposed to indicate that the metal came originally from the adjoining rocks. Further than this, he states that pieces of metallic zinc have been picked up along a range of thirty miles, over the Racoon Mountains, on the southern border of Tennessee, Sand Mountain, and the northern portion of Georgia and Alabama. The vein is now being explored, and Mr. Marks hopes to find the zinc in place."

This letter was written in 1876, and I have been unable to find any further remarks upon the subject bearing later dates, which fact lends itself to the conclusion that hitherto the occurrence of native zinc has been very doubtful. I think I am now in a position to prove that zinc does occur in the native state. The specimen on the table was brought in as a donation to the Queensland Museum some short time back by the Hon. B. B. Moreton, M.L.A.,who wished to know if the metal was silver. A very short examination before the blow-pipe showed me that it was zinc. The three fragments do not make sufficient amount to allow of my taking any for a complete analysis thereof, but I hope to do this at some later period when a larger specimen is obtained from the Gulf country, the locality where this was found. The metal is in irregularly fibrous masses, the colour of the fractural surface being white, and the streak the same colour; the hardness is 2, and the sp. gr. 7·52 at 62° F.; this is higher than the sp. gr. of manufactured zinc, which is from 6·9—7·2 according to the way in which it is cooled. The specimens are incrusted with a white substance which I find to be smithsonite, the carbonate of zinc.

As I have already remarked, I cannot be perfectly certain that native zinc has never been found before, but it assuredly is a new mineral for Queensland, and in either case is worthy of note. Native zinc can probably never be of commercial value, as it would require refining just as much as the zinc from other ores of the metal. The interest of the mineral from a scientific point of view, however, is not small.

I am given to understand that the specimens, the subject of this note, were not found in detached pieces, but formed part of a well-defined vein.

"On the Occurrence of Topaz in Association with Tin," by E. B. Lindon, A.R.S.M., etc.—Topaz, as everyone must be aware, is a very frequently and widely disseminated mineral in close conjunction with tin ore deposits, but I am unable to obtain sufficient data to tabulate or compare to any great extent the cases in which these are associated.

In a paper by Baron Von Groddeck, chief mining councillor of the Hartz Mining District (translated by Mr. G. Thureau, F.G.S.), on the tin ore deposits at Mount Bischoff, Tasmania, read before Royal Society, Tasmania, in September, 1885,* the baron draws attention to a kind of topaz rock of porphyritic structure, the white or light-coloured portions of the same consisting of dense topaz, whilst the greyish-blue were principally formed of dense tourmalines. The author, after mentioning that former reporters have considered the tin lodes to be enclosed by quartz porphyry, goes on to say: "If it has now been unmistakably proved that that specimen is actually not quartz porphyry, but a porphyritic topaz rock, then the question arises whether any such quartz porphyry occurs at Mount Bischoff at all, and whether the whole formation, assumed to be such rock, is not very probably a topaz rock, and in what manner, and under what conditions the latter occurs contiguously to the real quartz porphyry."

I have drawn somewhat at length from this article, as, given that it is a topaz rock, it is probably the most important of the associations of topaz and tin stone.

Tin ore is usually met with in veins traversing granite, mica-schist, gneiss, chlorite or clay slate, and porphyry, and is associated with topaz in Cornwall; at Schlackenwald and Zinnwald, Germany; at Durango and Guanaxuato, Mexico; and, to come nearer to us, traversing the eurite and greisen granites near Elsmore, N.S.W. Granite and gneiss also are the usual repositories of topaz.

J. A Phillips, in his work on "Deposits," says that M. Daubrée, some forty years ago, first called attention to the fact that, with the exception of quartz, the minerals most constantly associated with tin ore are compounds containing fluorine, principally fluorsilicates, such as lepidolite and topaz; sometimes also fluorphosphates and fluorides, the latter being present chiefly as fluorspar. Boron is a con-

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* "Remarks on Tin Ore Deposits at Mount Bischoff, Tasmania." *Pap. and Proc. R. Soc. of Tasm.*, 1885, pp. 388-394.

stituent of the mineral tourmaline and axinite, both of which are frequently present in the deposits, while the most commonly associated elements are tungsten, molybdenum, phosphorus, arsenic, and iron. He arrives, therefore, at the conclusion that tin ore, fluorine compounds, and borosilicates owe their origin to the same set of reactions, and supposes that the tin, tungsten, molybdenum, boron, phosphorus, and a portion of the silicon came up through fissures from some deep-seated source of fluorides. Finally, he suggests that the present condition of stockwerks, which consist of quartz, tin ore, silicates, fluorsilicates, and borosilicates, have resulted from the action of these fluorides, probably in the presence of water, on the enclosing rocks.

EXHIBITS.

Mr. H. Tryon exhibited *Alunite*, from Bulladelah, New South Wales. Mr. E. B. Lindon alluded to the process by which alum was obtained from this mineral, and its composition as compared with other alum minerals.

Mr. H. Tryon also exhibited the egg of a common black hen, which had weighed $5\frac{1}{4}$ ounces, and which measured 3.4 inches by 2.2 inches. This egg included a second egg, measuring 2.5 inches by 1.5 inches. The shell of each egg was well developed, and in both were food-yolks and albuminous matter in normal proportions. Mr. Tryon alluded to the short time prior to their being laid when these eggs must have come into their relative positions, and how this had been effected. This double egg had been forwarded to the Queensland Museum by Mr. Price Fletcher, of Brisbane.

Mr. J. Thorpe exhibited a barograph-tracing for the month of November, and drew attention to the chief incidents which it illustrated. He also commented on the invariable influence on these tracings of the passage of an area of low barometric pressure across the South of Australia, from W. to E.

Mr. J. Falconer, C.E., exhibited different auriferous rocks of secondary origin, as cements and gossams, derived from ores which had been worked for copper. He also dwelt at length on the importance to the country of the establishment and conduct by the Government of works, similar to those in Sydney, where ores could be tested on a large scale, and by the use of machinery of the best class available for the particular treatment they required.

APPENDIX.

(Read on the 3rd December, 1886.)

THE REPORT TO THE PRESIDENT AND MEMBERS OF THE ROYAL SOCIETY OF QUEENSLAND OF ITS REPRESENTATIVE, COMMISSIONED TO ATTEND A MEETING, HELD IN THE HOUSE OF THE ROYAL SOCIETY OF NEW SOUTH WALES, ELIZABETH STREET, SYDNEY, ON WEDNESDAY, THE TENTH OF NOVEMBER, AT THREE O'CLOCK IN THE AFTERNOON, FOR THE PURPOSE OF MAKING THE PRELIMINARY ARRANGEMENTS IN CONNECTION WITH A PROJECTED AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

In compliance with a commission, given by the Council of the Royal Society of Queensland, on Monday, 1st October, whereby Mr. Henry Tryon was appointed to represent the members at a preliminary meeting, convened in connection with the formation of a proposed Australasian Association for the Advancement of Science, your representative proceeded to Sydney, in the s.s. "Maranoa," which left Brisbane on Friday, the 5th November, and arrived there on Sunday, 7th November.

On the day following his arrival in Sydney, your representative waited on Professor Liversidge, the convener of the meeting, and advised him, as had been previously done by letter also, of the fact of his appointment as representative of the Society at it.

The meeting was held, as previously announced, in the room of the Royal Society of New South Wales, on Wednesday, 10th November, and your representative attended the same, by virtue of his commission.

At this meeting, Mr. H. C. Russell, B.A., F.R.S., Government Astronomer of New South Wales, presided, and the different scientific societies throughout Australasia were represented as follows :—

VICTORIA.

Field Naturalists' Club of Victoria,	Rev. Dr. Wools, F.L.S.
Geological Society of Australasia,	Mr. R. T. Litton, F.L.S.
Historical Society of Australia,	Mr. R. T. Litton, F.L.S.
Royal Society of Victoria,	Mr. K. T. Murray.
Victorian Institute of Surveyors,	Mr. W. N. Conder and Mr. W. H. Nash.
Victorian Engineering Association,	Professor Kernot, M.A., and Mr. K. T. Murray.

QUEENSLAND.

Royal Society of Queensland,	Henry Tryon.
Geographical Society of Australasia, Queensland Branch,	J. P. Thomson, M.A., C.E.

TASMANIA.

Royal Society of Tasmania,	James Barnard.

NEW ZEALAND.

Philosophical Institute of Canterbury,	S. Herbert Cox, F.C.S., F.G.S.
Nelson Association for the Promotion of Science and Industry,	S. Herbert Cox, F.C.S., F.G.S.

NEW SOUTH WALES.

Linnean Society of New South Wales,	Prof. Stephens, M.A., and J. J. Fletcher, M.A., D.Sc.
Royal Society of New South Wales,	H. C. Russell, B.A., F.R.S. Prof. Liversidge, F.R.S., and C. S. Wilkinson, F.G.S., F.L.S.
New South Wales Zoological Society,	Dr. A. T. Holyrod.
Geographical Society of Australasia,	Sir E. Strickland.

The Chairman (Mr. H. C. Russell) remarked that Professor Rolleston, C.M.G., not being present, he had been prevailed upon to take the chair. He regretted that gentleman's absence as he himself had little knowledge of what was intended to be done and felt it therefore his duty to at once ask Professor Liversidge, the convener of the meeting, to inform those present on this head.

Professor Liversidge, in response, explained that the object of the meeting was the formation of an Australian

Association for the advancement of Science, and he supposed they had all received a circular setting that object forth. Their business was to frame conditional rules and to appoint a date for the first meeting in 1888, that year having been partly fixed upon because it was the hundredth anniversary of this colony, and when this subject was proposed it was thought that there would be an exhibition here that year and therefore a good time for the meeting of scientific men. The exhibition contemplated appeared to have fallen through, and it was for those present to say whether this meeting in 1888 should take place or not.

The Chairman stated that the first resolution had been put down on the business paper to be proposed by Mr. Rolleston, but he (the Chairman) was bound to move it in that gentleman's absence. It was one about which he thought there could not be much question. The resolution was—

"That an association of the scientific societies of Australasia be formed under the name of the Australasian Association for the Advancement of Science."

There had been hitherto in these colonies a great want of united action, and many subjects which might have been taken up had not been. It was therefore desirable that they should, by every means in their power, form associations for the furtherance of investigation. There were many objects for investigation which men coming from the civilised world took the honor and credit of discovering that might otherwise belong to these colonies. The formation of the Association would be the means of stirring them up to work which they had hitherto left undone.

Sir Edward Strickland seconded the motion, which was unanimously carried.

Professor Stephens then moved—

"That the rules of the British Association, *as printed*, be adopted by the Australasian Association for the Advancement of Science. and such other rules of the British Association be followed as may be necessary until the first meeting of the Australasian Association."

NOTE.—The rules referred to in this motion being "Rules of the British Association, somewhat modified," were the following :—

Membership.

1. All persons who signify their intention of attending the first meeting shall be entitled be become original Members of the Association upon agreeing to conform to its Rules.

2. The Officers, Members of Council, Fellows, and Members of Literary and Philosophical Societies, publishing Transactions or Journals in the British Empire, shall be entitled in like manner to become Members of the Association. Persons not belonging to such Institutions shall be elected by the General Committee or Council to become Life Members of the Association, Annual Subscribers,or Associates for the year, subject to the payment of the prescribed Subscription, and the approval of a General Meeting.

Publications.

3. All Members who have paid their Subscriptions shall be entitled to receive the Publications of the Association *gratis.*

Place of Meeting.

4. The Association shall meet for one Week or longer. The place of meeting shall be appointed by the General Committee two years in advance.

General Committee.

5. There shall be a General Committee or Council, having the supreme control, to be composed of delegates from the different Colonies or Colonial Scientific Societies. The number of delegates from each Society or Colony shall be proportionate to the number of members from the particular Colony or Society—subscribing or otherwise—taking part in the proceedings (*i.e.*, after the preliminary meetings); each Colony or Society shall be allowed to nominate a delegate for say each one hundred of its members.

If the General Committee be established on the basis suggested, viz.: One delegate to each 100 members or less, the total number of such representatives would be about twenty-five or thirty, since there are some twenty Scientific Societies in the Australasian Colonies, and the number of members is between 2500 and 3000.

Local Committees.

6. A local Committee shall be appointed in the place of meeting, to make arrangements for the reception and entertainment of the visitors, and to make preparations for the business of the General Meetings.

Sectional Committees.

7. Sectional Committees shall be appointed for the following subjects :—

SECTION A—Astronomy, Mathematics, Physics, and Mechanics.
SECTION B—Chemistry and Mineralogy.
SECTION C—Geology and Palæontology.
SECTION D—Biology.
SECTION E—Geography.
SECTION F—Economic and Social Science and Statistics.
SECTION G—Anthropology.
SECTION H—Medical and Sanitary Science.
SECTION I—Literature and the Fine Arts.
SECTION J—Architecture and Engineering.

Privileges of Members.

8. The rights and privileges of membership shall be in the main similar to those afforded by the British Association, subject to revision and alteration after the first meeting of the proposed Australasian Association for the Advancement of Science.

Meeting and Excursions.

In addition to the General and Sectional Meetings for reading and discussing Papers, &c., it is proposed that Excursions should be organised to various places of interest, such as the various Mining Districts, the Jenolan, Wambeyan, and other caves, the Blue Mountains, and similar places of interest to geologists and others.

Your representative drew attention to, with a view to their criticism, several of these rules *as modified* and especially dwelt upon.

1st. The words *"in the British Empire"* in Rule 2 as scarcely applicable to an Australasian Association.

2nd. The words *"prescribed subscriptions"* in the same Rule, as conveying no meaning in the absence of any other allusion to the same subject.

3rd. The omission of *annually* after the word meet in Rule 4, or some other words denotive of the frequency of the meeting.

4th. The word *or* connecting the expressions General Committee and Council respectively in Rule 5, as implying by the use of this conjunctive that these bodies were identical, in the British Association, and did not each perform very distinct and equally important functions, one having a temporary and the other a somewhat permanent existence and both necessary.

Professor Liversidge having briefly responded to these criticisms, the original motion without amendment was seconded by Mr. J. P. Thomson and carried.

Professor Kernot then moved:—

"That the president, honorary secretaries, and honorary treasurer be elected annually by ballot from amongst the representatives of the colony in which the meeting is to be held. The first election of officers shall be held in Sydney in March, 1888."

He said that the three bodies with which he had the honour of being connected in Victoria had all received the proposal for the formation of an Australasian Association for the Advancement of Science with the greatest heartiness. No one had any shadow of misgiving as to the thing being good, and the sooner it was done the better. He took that opportunity of assuring the scientific gentlemen present that the three bodies he represented gave the scheme of federation of the scientific societies their hearty adherence, and would be most happy in every possible way to assist at the meeting of the Association, which he trusted would be held in 1888.

Mr. R. T. Litton seconded the motion.

Mr. J. P. Thomson inquired whether this first election of officers in March, 1888, would necessitate the attendance of delegates in Sydney, as such a course would be very inconvenient to both your representative and himself, who in Queensland, in addition to the duties connected with the respective societies to which they belonged had to attend to official duties also, and could not at all times find it convenient to get away; besides the societies were put to expense in sending their representatives to Sydney. He thought that some provisional organisation ought to be formed, as he failed to see how the meeting could transact business without recognising in itself some form of constitution necessary for present and future action.

Professor Liversidge stated that he would arrange for the election of officers by ballot to be so conducted as to avoid the necessity of again meeting for that purpose.

Your representative endorsed the remarks of Mr. Thomson, and stated his opinion that the meeting should do something more than affirm the assurances (already given by letter) of the different societies which had entertained the project of the Association. He inquired also, with the understanding that no members of the Association were to be enrolled prior to March, 1888, who then were competent to nominate the officers whom it was proposed to elect?

As no amendment, however, to Professor Kernot's motion was made, this, as it originally stood, was put to the meeting and carried.

Mr. S. H. Cox then moved—

"That the first meeting of the Association be held in the first week in September, 1887."

Mr. Conder seconded the motion, which was carried unanimously.

Your representatives moved—

"That Professor Liversidge, F.R.S., be the appointed convener for the next meeting."

Mr. K. L. Murray seconded the motion, which was carried unanimously.

On the motion of Professor Stephens, seconded by Mr. Litton, a unanimous vote of thanks was then accorded to Professor Liversidge for the part he had taken in promoting the movement.

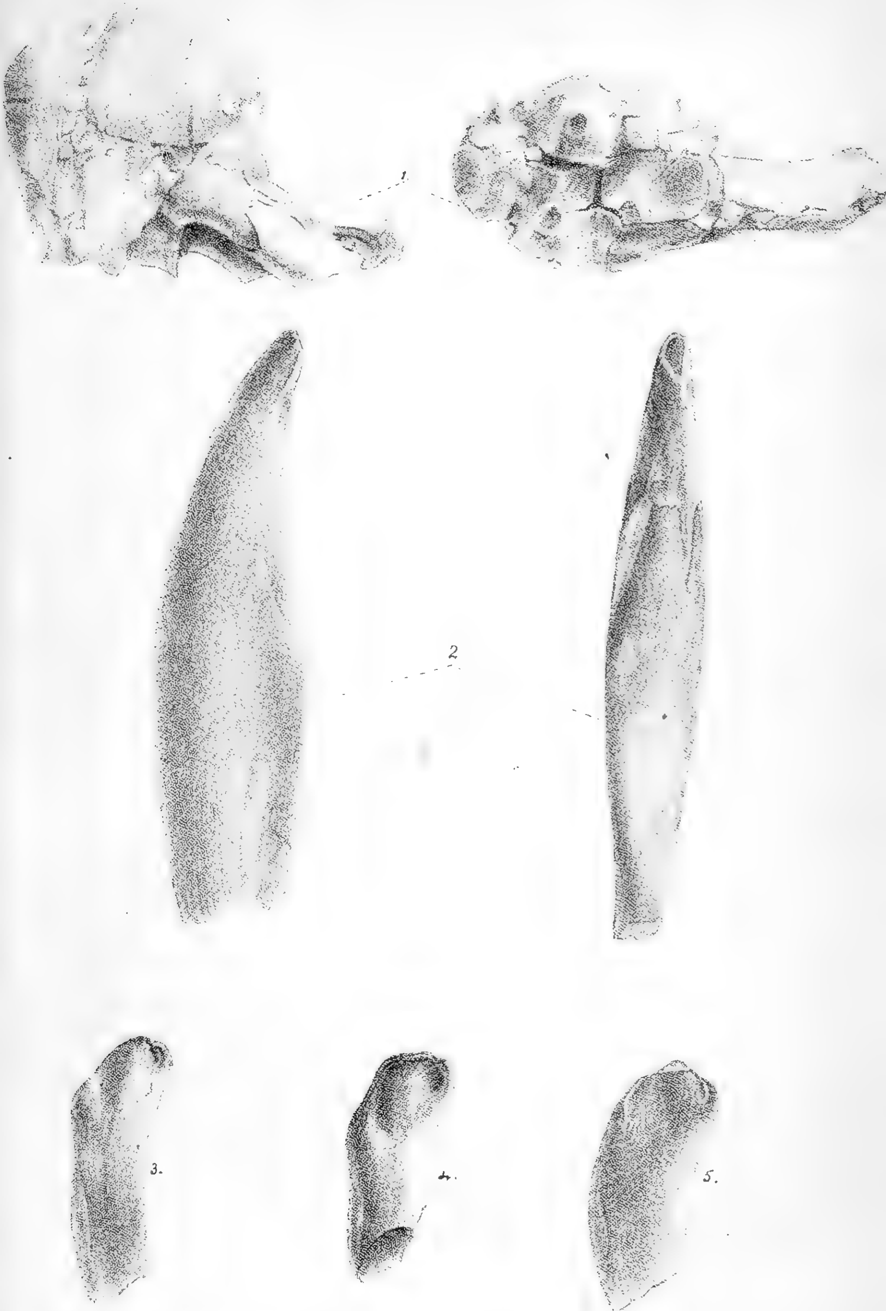
Professor Liversidge thereupon briefly acknowledged the honour conferred upon him by the adoption of this resolution and dwelt on the interest manifested by the different societies in the formation of the Association.

The meeting afterwards dispersed.

No further meeting of the representatives from the different societies was then or afterwards convened, and your representative was therefore at liberty to leave Sydney for Brisbane by the first opportunity—that of a steamer leaving on Friday, 12th November.

(Signed) HENRY TRYON.

INDEX.



Prochœrus celer, (De Vis).

1. Molar tooth. 2. Lower incisor.

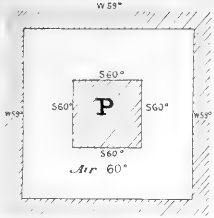


Fig. 1.

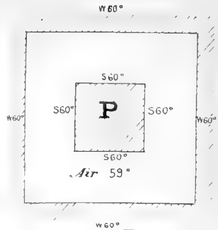
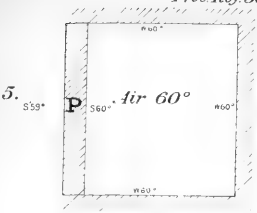


Fig. 2.

Fig. 5.



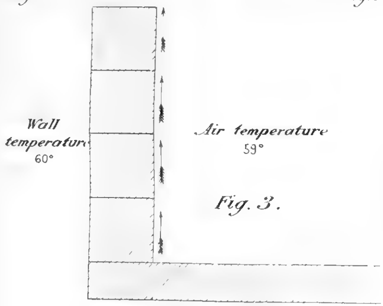


Fig. 3.

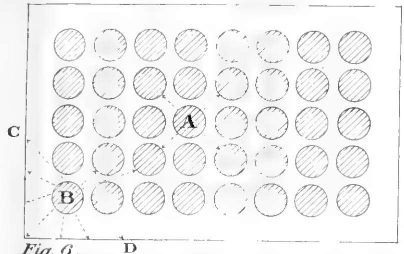


Fig. 6.

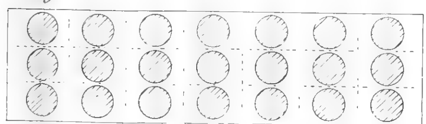


Fig. 7. Screens thus - - - -

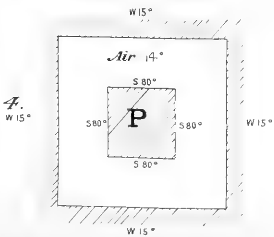


Fig. 4.

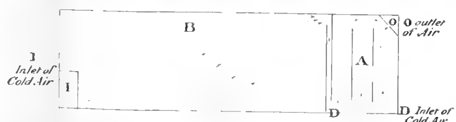


Fig. 8.

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