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VOLUME XXXIV.

Presidential Address.

By C. T. White, F.L.S. (Government Botanist of Queensland.)

(Delivered before the Royal Society of Queensland, 11th April, 1922.)

I have taken as the scientific portion of my address a "Contribution to our Knowledge of the Flora of Papua (British New Guinea)," based on collections made there by me in 1918, but before proceeding with this subject would like to touch on a few matters of the past year of general interest to scientific workers in Queensland.

The Council's report for the past session shows that satisfactory progress has been made. It was regrettable that towards the end of the year the Council was obliged, owing to lack of funds, to discontinue the publication of papers submitted. By a special effort, however, the honorary treasurer (the late Dr. Shirley) was able before the end of the year to place our finances on a more satisfactory basis.

A sad feature has been the loss by death of four members of the Society.

William J. Byram, who died on the 10th March, 1922, was a native of Brisbane. He was educated at the Brisbane Grammar School, where in 1880 he won the Lilley Gold Medal as head of the school. He was well known in legal and business circles in Brisbane. He was a good classical scholar, and within the last few years of his life had produced a verse translation of Æschylus' "Prōmetheus Vinctus" so scholarly and so poetic, especially in the rendering of its choruses, that Prof. Gilbert Murray (Oxford Professor of Greek), to whom it was submitted, said he was proud to think it was the work of a fellow-countryman (he himself being an Australian). The translation is now in the Queensland University Library, where it may serve as an incentive to future classical scholars. The late Mr. Byram was a keen microscopist, being especially interested in Freshwater Algæ, and helped the late F. M. Bailey in bringing out the three bulletins of the Botany Series published by the Queensland Department of Agriculture and Stock devoted to the Freshwater Algæ of Queensland, by translating from the German the original descriptions forwarded to Mr. Bailey from European specialists who had submitted to them the material upon which the bulletins referred to were based. An appreciation of the late Mr. Byram from the pen of Mr. R. H. Roe, one-time head master of the Brisbane Grammar School and later Director of Education in Queensland, appeared in the *Brisbane Courier* for the 18th March, 1922, and from this some of the above facts have been taken.

Robert Logan Jack, LL.D., F.R.G.S., F.G.S., who died in Sydney in November, 1921, was born at Irvine, Ayrshire, Scotland, on the 16th September, 1845, and was educated at the Irvine Academy and Edinburgh University. For some years he was attached to the Geological Survey of Scotland and also conducted geological work on the Continent. In 1877 he was appointed Government Geologist for Northern Queensland in succession to Richard Daintree, and was soon afterwards appointed Chief Government Geologist for Queensland. While holding office he conducted much exploratory work, and published a number of original contributions to our knowledge of the geology of the State. In 1893, in collaboration with R. Etheridge, junr., he brought out the well-known "Geology and Palæontology of Queensland and New Guinea." In 1898 he was appointed Commissioner for Queensland to the Earl's Court Exhibition, London, and while there received an offer from an English company operating in the East which caused him to resign his position as Government Geologist of Queensland. Operations in the East ceasing owing to the Boxer outbreak, he returned to England, where he started private practice as a consulting geologist and mineralogist. He returned to Australia in 1904, and was for some years engaged in private practice in West Australia, afterwards coming to Sydney. For some years before his death he was engaged on a study of the history of exploration in Northern Australia, and the two-volume work "Northernmost Australia" is the result.

John Shirley, D.Sc., F.M.S., a past-president, hon. secretary, and for some years before his death the very efficient hon. treasurer of this Society, who died in Brisbane on the 5th March, 1922, was born at Dorchester, England, on the 11th August, 1849. With the passing of Dr. Shirley Queensland has lost one of its most brilliant educationalists and the Royal Society and also the Australasian Association one of their most zealous officers. Dr. Shirley began official life as a pupil teacher, being trained in the Curzon-street National School, Derby, England, and subsequently entered as a student of the Saltley Training College, where he remained till 1869.

After completing his course in the training college he was employed for a period of eight years in Bishop Ryder's Boys' School, Birmingham, and whilst at that school graduated as B.Sc. of the London University. He arrived in Queensland in

May 1878, and on 1st June of that year was appointed head teacher of the State School at Roma. In 1879 he was appointed District Inspector of Schools and in 1909 Senior Inspector. When the Teachers' Training College was established in 1914 he was selected for the position of principal. He held this post till the end of 1919, when he was retired under the provisions of the Public Service Act. The following year, however, he was appointed conchologist to the Queensland Museum, a post he had in previous years filled in an honorary capacity. This position he held for one year and nine months, when the pruning knife of retrenchment did away with the position. It was characteristic of him that when over sixty years of age he employed the long leave due to him for continuous Government service in studying, and preparing a thesis for the degree of Doctor of Science at the Sydney University. He was a versatile writer on scientific subjects, being one of the older school of naturalists whose studies covered a number of branches of natural science. His most important published work was the "Lichen Flora of Queensland" (mostly first published as a series of papers in the Proceedings of this Society).

The Hon. Ernest James Stevens, M.L.C., who died at Brisbane on the 3rd March, 1922, was born at Melbourne on the 10th July, 1845. He came to Queensland in 1868 and for some years engaged in pastoral pursuits. He was elected M.L.A. for Warrego in 1878 and for the Logan in 1883. He retired in 1899 and was called to the Legislative Council. He was one of the more prominent business men of Queensland, for some years among other posts being chairman of directors of the Brisbane Newspaper Company Limited.

In April the Council was aked to nominate candidates for election to the newly formed Australian National Research Council. It is hoped the formation of the Council will materially aid scientific advancement in the Commonwealth.

The early part of 1921 was marked by the holding of the Hobart-Melbourne meeting of the Australasian Association for the Advancement of Science. The meeting was the first held since 1913, and such a long time elapsing between meetings gave many of us the opportunity of again meeting old friends from other States, and kindred spirits whom previously we only knew by reputation or through correspondence. It is much to be regretted that funds did not permit the many papers read being printed as a record. Many, however, have since appeared in various scientific periodicals.

An event of interest among local natural history circles was the amalgamation of the Queensland Field Naturalists' Club with the Gould League of Bird-lovers, under the title of the "Queensland Naturalists' Club," the Gould League being embodied in a junior section known as the "Nature-lovers' League." In the past both bodies have done excellent work in their respective spheres, and it is hoped the amalgamation will mean an increased activity in natural history matters in Queensland, particularly in fostering a love among the rising generation for our beautiful native birds, animals, and plants.

The inauguration of a Queensland branch of the British Empire Forestry Association at a public meeting held during the Interstate Forestry Conference recently held in Brisbane, is a matter for congratulation, and it is hoped the newly formed association will be able to foster a keen public spirit towards forestry matters in Queensland, particularly as regards the conservation and regeneration of our more important timber trees. Our total tree flora is not yet known and every year sees new species brought to light, and I would here make a plea for a proper botanical survey of our more richly timbered areas, particularly those at present little known.

In his "Discussion of Australian Forestry" the late Sir D. E. Hutchins states: "Those who do not know Australia will hardly credit the assertion that after a white occupation of one hundred years or more the country is still without a single national arboretum." He goes on to describe the large arboretum at Tokai, near Capetown, South Africa, in which about 150 species of eucalypts are growing. He then goes on to make a plea for the establishment of suburban forests or arboreta near the larger towns. "The Centennial Park," he says, "is a splendid open space in nearly the centre of Sydney for a suburban forest. Certainly if one-third of the space was kept open for lawns, flower-beds, and ornamental water, the remaining two-thirds might be devoted to an arboretum, which would be the centre of arboriculture in New South Wales and from many points of view would be the leading feature of the city of Sydney." In Brisbane we have a similar large open space in Victoria Park, at present a more or less neglected area, which would make an ideal site for a large collection of trees within the city boundaries. It has one feature in common with the Centennial Park—i.e., a very poor, barren soil—but a lot of this land could be reclaimed with city refuse at a reasonable cost.

A Contribution to our Knowledge of the Flora of Papua (British New Guinea).

By C. T. White, F.L.S. (Government Botanist of Queensland.)

(Scientific Portion of Presidential Address delivered before the Royal Society of Queensland, 11th April, 1922.)

INTRODUCTORY.

In June 1918 I received an invitation from His Excellency Judge Murray, Lieutenant-Governor of Papua, to visit the Territory for the purpose of studying its vegetation, of which comparatively little is known. The invitation came at a time when six weeks' leave of absence was due to me from the Queensland Department of Agriculture and Stock. Pressure of other matters prevented me from spending much more than my official leave on the visit, and only between five and six weeks' actual collecting was spent in the field. About 800 species of vascular plants were gathered; the majority of the material has now been worked out and the results are here set forth.

The references to literature are confined to such as refer to the occurrence of the particular species in the territory of Papua (British New Guinea). Some of the families have been sent to various specialists for examination, and to these botanists I must express my special thanks. To Dr. Rendle, Keeper of Botany, British Museum of Natural History, I am indebted for arranging for Mr. Spencer Le M. Moore, B.Sc., F.L.S., to work out the Acanthaceæ and Rubiaceæ; also for handing over to Mr. H. N. Ridley, late Director of Botanic Gardens, Singapore, the specimens of Musaceæ, Zingiberaceæ, and Marantaceæ. To Mr. J. H. Maiden, Director of Botanic Gardens, Sydney, I am indebted for the identification of the eucalypts, and for arranging for the working out of the ferns by Mr. Whitelegge and the Loranthaceæ by Mr. Blakely.

I have taken the opportunity of recording a few plants for Papua from specimens in the Queensland Herbarium, that had been lying there undetermined for some years. There still remains more doubtful material in the Queensland Herbarium, and I hope to work these specimens out later along with my own undetermined material.

ITINERARY.

After a few days' stay in Port Moresby, I left in company with the Papuan Government Geologist (Mr. Evan R. Stanley) and fifteen carriers for the Sogeri Plateau and Javararie, *via* Sapphire Creek and the Astrolabe Range (about 2,000 feet). After about a fortnight spent in this territory, I returned to Port Moresby and after a few days' stay left for Yule Island and Mafulu, again having the advantage of the company of Mr. Stanley.

At Yule Island twenty-five native carriers were obtained for carrying the camping outfit, collecting gear, specimens, &c. The journey was made over to the mainland and up the Ethel River as far as Bioto by native canoes. Time did not permit of much collecting along the banks of the Ethel River, though the mangrove swamps, Nipa palms, and rich tropical vegetation fringing the banks of the river and of Bioto Creek promised a good field for the botanist.

On reaching Bioto, the canoes were drawn up on the bank and the five days' march to the mountains commenced, the following places being stopped at *en route*:—Kubunah, Fofofofo, Dilava, Deva Deva, Mafulu, and Bella Vista. An excellent well-graded road has been surveyed and made under the direction of the Mission Fathers, from Bioto as far inland as Ononge, which makes travelling in this country comparatively easy; and travellers in the Mekeo, Dilava, and Mafulu districts—the sphere of influence of the Roman Catholic missions—are indebted to the missionaries for the facilities with which travelling can be accomplished in these parts of Papua.

GENERAL NOTES ON THE VEGETATION.

The vegetation about Port Moresby reminds one of much of the open forest country in parts of North Queensland with a similar rainfall (about 40 in.). It consists for the most part of grass-covered hills with scattered white-barked eucalypts (*E. papuana* and *E. alba*) of rather stunted growth dotted about.

Other very common trees on the hills are *Alstonia scholaris* (Milky Pine), and *Albizzia procera*. A cycad (*Cycas media*) is also very abundant. In the gullies and round the sea-beach are found patches of thin scrub supporting a more varied flora. Every here and there bright masses of scarlet can be seen—the flowers of *Bombax malabaricum* (the Silk Cotton tree)—a large tree ranging through North Australia, New Guinea, and Tropical Asia. Round about the rocky sea-coast, near the town, *Cochlospermum Gillivræi* (a small tree) is conspicuous on account of its numerous large, yellow, buttercup-like flowers. *Cordia subcordata* is another fairly common shrub in the same situation.

Swampy patches occur in which the Sago Palm (*Metroxylon* sp.) and Breadfruit (*Artocarpus incisa*) predominate. The mangrove flora along the southern coast is similar to that of the North Australian and Malayan regions, consisting of *Rhizophora*, *Bruguiera*, *Ceriops*, *Sonneratia*, *Avicennia*, *Ægiceras*, and *Carapa*. *Acanthus ilicifolius* is in some parts also abundant. A common climber over mangrove trees is *Dalbergia monosperma*. Along the Ethel River and Bioto Creek the Nipa Palm (*Nipa fruticans*) is a conspicuous feature lining both sides of the banks. Along the Ethel River I also collected specimens of the apparently little-known *Sonneratia lanceolata*. It is a small tree very much resembling some forms of *Avicennia officinalis* in appearance; its pneumatophores also are like those of *Avicennia*, and do not attain the large size of its congener *S. alba*.

On the Astrolabe Range (about 3,000 feet), Hombrom Bluff, Mt. Warirata, etc., the vegetation for the most part is of an open character, the principal forest trees being eucalypts (principally *E. tereticornis*) with patches of *E. alba* and *E. clavigera*, *Casuarina nodiflora*, *Banksia dentata*, *Melaleuca* sp. (a Paper-barked Tea-tree), *Diplanthera tetraphylla*, *Grevillea pinnatifida*, and *Timonius Rumphii*. At Bisiatabu I was interested to find *Nepenthes Moorei* to be a common plant in the poorer open, dry, forest country. The lower trees in the same place supported a number of plants of *Myrmecodia* and *Dischidia*. On the Sogeri Plateau itself the vegetation is very rich and tropical, the plateau being mostly covered with heavy rain-forest in which the usual Malayan orders and genera predominate. Zingiberaceæ and Marantaceæ are particularly abundant. *Mucuna Krœtkei* is a forest climber with long pendulous racemes of brilliant scarlet flowers and is known locally as the "D'Albertis Creeper," a name applied in a general sense by the white people resident in Papua to any climber of the genus *Mucuna*.

Sogeri Plateau is a great centre of rubber cultivation, and several large and successful plantations have been established there. Further on, Javararie—nearly 50 miles by road from Port Moresby—is one of the oldest rubber plantations and produces some of the finest rubber in the Territory; but the lack of decent road communication with the seaport militates greatly against its financial success. Botanically, round Javararie the country is particularly rich and tropical in character, and a large number of plants was here gathered.

On Yule Island and on the mainland opposite the vegetation is somewhat similar to that about Port Moresby. In the ranges about Mafulu (about 4,000 feet) the vegetation is extremely rich and varied, consisting almost entirely of heavy rain-forest. Among trees the ordinary Malayan types predominate; ferns, lycopods, begonias, palms, bamboos, and other typical tropical forms are abundant. The occurrence of *Grevillea* is a connecting link with the flora of Australia, while *Quercus*, *Castanopsis*, and *Begonia* are Asiatic types not as yet found in Australia.

A BRIEF HISTORY OF BOTANICAL WORK IN PAPUA.

There has been considerably less botanical work accomplished on the territory of Papua or British New Guinea than in either the Dutch or late German territories. In his introductory notes to the Botany of the Wollaston Expedition, Dutch New Guinea (in Trans. Linn. Soc., vol. ix, Bot. 2nd series), Mr. H. N. Ridley stated: "The flora of British New Guinea has been more neglected than that of Dutch and German New Guinea; except for Forbes's collections on the Sogeri Mountains, which have not yet been fully worked out, and a small lot obtained by MacGregor and Guilianetti, no collecting of importance has been done there."

In 1875 Wm. Macleay (afterwards Sir. Wm. Macleay) conducted an expedition to the islands of Torres Strait and to New Guinea. J. Reedy accompanied the expedition as an horticultural emissary of Sir William Macarthur. The specimens he collected formed the material for the first part of Mueller's "Descriptive Notes on Papuan Plants."

In 1875 the Rev. Dr. McFarlane, in search of suitable places to establish mission stations, made the first voyage up the Baxter and Fly Rivers. He collected a number of plants, which were described by Baron Ferdinand von Mueller in his "Descriptive Notes on Papuan Plants," vol. i, pts. 2 and 3.

In 1876-7 Mr. Andrew Goldie, first in conjunction with the Rev. Dr. McFarlane and, in a later expedition, by himself, forwarded collections of plants to Baron Mueller, which were described by the Baron in his "Descriptive Notes," vol. i, Nos. 3, 4, and 5.

During 1875-7 the famous explorer Signor D'Albertis conducted explorations up the Fly River and made important collections. These were determined in part by Dr. O. Beccari in D'Albertis' "New Guinea," vol. ii, pp. 391-400, and in part by Baron Mueller in "Descriptive Notes" (vol. i, Nos. 4 and 5). Some of his plants are also described in Beccari's "Malesia."

In 1884 the *Argus* and the *Age* (Melbourne newspapers) sent special commissioners to Papua to report upon its resources and capabilities for settlement. The *Argus* Expedition was commanded by Mr. W. E. Armit, an officer of the Queensland Native Police; he was a true plant-lover, and his specimens were referred to by Mueller in odd numbers of the "Victorian Naturalist" for the year 1885.

During 1884-1887 Theodore Bevan conducted several expeditions to totally unexplored or little-known parts. His collection of plants was briefly noted by Mueller in "Proceedings of the Linnean Society of N.S.W.," vol. ii, n.s.

During the same period the Rev. Jas. Chalmers forwarded to Baron Mueller several small collections. These were noted by Mueller in his "Descriptive Notes" Nos. 6-8.

In 1885, H. O. Forbes, well known as an explorer through having conducted expeditions in Sumatra, Timor, and some of the lesser-known islands of the Malayan Archipelago, visited New Guinea for the purpose of exploring the Owen Stanley Range. Unfortunately, owing to lack of funds and other obstacles, Forbes was not able to realise his object, and a large camp was established at Sogeri, where most of the collecting was accomplished. The Monocotyledonous plants were described by H. N. Ridley (Journal of Botany, vol. xxiv), but the great bulk of Forbes's collections, sad to say, remain undetermined to this day, and odd references to new species collected by Forbes are now and again met with in current literature dealing with the flora of New Guinea. It is interesting to record here that this Society, through the efforts of its then hon. secretary (Mr. H. Tryon), was able to send to Forbes the sum of £100 in aid of his work.

In 1886 the Geographical Society of Australia despatched a well-equipped expedition under the leadership of Captain H. E. Everitt. Mr. W. Bauerlen accompanied the party as botanical collector, and his collections were determined and described by Baron Mueller in his " Descriptive Notes " (vol. ii, Nos. 7 and 8). Bauerlen also issued a booklet, " The Voyage of the Bonito" (Sydney 1886), giving an account of the voyage, but it contains little botanical matter.

In 1887 Messrs. Cuthbertson, Sayer, and Hunter ascended Mt. Obree. Sayer, well known as a botanical collector and one of the first white men to ascend Bellenden-Ker, North Queensland, collected a number of plants which were described by Mueller in the " Victorian Naturalist" and his " Descriptive Notes." Only a very few plants were noted, and I think a number more are probably lying undetermined in the National Herbarium, Melbourne.

In 1887 C. Hartmann, a well-known Queensland plant enthusiast, accompanied by G. Hunter, ascended the eastern bank of the Kemp-Welch River and pushed forward with the intention of going to the top of the range between Mt. Brown and Mt. Obree, an ideal not fully realised. They are reputed to have collected a large series of specimens. I can find very few references to Hartmann's specimens—only a few by Mueller (" Descriptive Notes ") and Bailey (" Queensland Agricultural Journal "). Possibly the main bulk are still lying undetermined in the National Herbarium at Melbourne.

In 1889 Sir William MacGregor ascended the Owen Stanley Range to its highest point (Mt. Victoria, 13,121 feet), and collected an important series of specimens from the higher altitudes. These were described by Baron Mueller in " Transactions of the Royal Society of Victoria," vol. i, pp. 1-45. It constitutes one of the most important contributions to our knowledge of the flora of the territory. During his term of office as Lieutenant-Governor of Papua, Sir William MacGregor collected a number of specimens of plants. These were determined by Mueller and recorded in various papers, largely as appendices to the Annual Reports of British New Guinea.

In 1895-6 H. Tryon visited British New Guinea, as an emissary of the Queensland Department of Agriculture, for the purpose of procuring varieties of sugar-cane for cultivation in Queensland. Tryon spent about 4½ months in the territory and brought back to Queensland 65 varieties of sugar-cane from native gardens. Some of these, e.g. Badila, are among the most generally cultivated in Queensland at the present time. A very comprehensive report by him on his collections was unfortunately never printed.

In 1897 (after Mueller's death) Sir William MacGregor forwarded to the Royal Botanic Gardens, Kew, a collection of plants from the higher parts of Mt. Scratchley. This was followed up by a collection from the Vanaipa Valley and Wharton Range, made by A. C. English. These two collections were described in the "Kew Bulletin" for 1899, pp. 95-126. Lists are also given in the Annual Report of British New Guinea for 1897-8.

In 1898 F. M. Bailey, Colonial Botanist of Queensland, accompanied His Excellency Lord Lamington (then Governor of Queensland) and Sir Hugh M. Nelson on a tour of inspection of British New Guinea. He gives a list of the plants observed in an appendix of a parliamentary paper, "Report of Visit to British New Guinea" (1898). The new species collected were described in the "Annual Report of British New Guinea" and "Queensland Agricultural Journal."

From 1899-1903, during his years of office as Lieutenant-Governor of the Territory, Sir G. R. Le Hunte forwarded a number of specimens to F. M. Bailey for determination. These were described in the pages of the "Queensland Agricultural Journal" and as appendices to the "Annual Reports of British New Guinea."

During 1904-7 Captain F. R. Barton, while holding the post of Administrator, forwarded several lots of specimens to F. M. Bailey for examination. These were described in the "Queensland Agricultural Journal" and one collection in the Proceedings of this Society (vol. xviii).

In 1908 Gilbert Burnett, a Queensland district forest inspector, visited Papua for the purpose of reporting on the timber resources of the territory. His report is embodied in the "Timber Trees of the Territory of Papua," a 45-page booklet issued by the Department of External Affairs, Melbourne. Of the numerous timbers listed, with two or three exceptions, only native Papuan names are given. A fine opportunity was here lost of doing good botanical work.

In 1908 Mrs. H. P. Schlencker, wife of one of the London Missionary Society's officers, made collections about Boku.

These were determined and described by F. M. Bailey and the results published in his "Contributions to the Flora of British New Guinea" series in several issues of the "Queensland Agricultural Journal," during 1909.

In 1911 E. B. Copeland described in the Philippine Journal of Science (vol. vi, section C, pp. 65-92) a number of ferns submitted to him by the Rev. Copland King. The Rev. King was a keen collector of Papuan ferns and orchids, and practically speaking confined his attention to these plants. His orchids and many of his ferns were described by F. M. Bailey in the pages of the "Queensland Agricultural Journal" in his series "Contributions to the Flora of British New Guinea."

PTERIDOPHYTA.

(Determined by Thos. Whitelegge, Consulting Pteridologist, Botanic Gardens, Sydney).

POLYPODIACEÆ.

Aspidium subtriphyllum Hook. Astrolabe Range.

A. cucullatum Christ. Mt. Warirata (Astrolabe Range).

Nephrolepis floccigerum Moore.

N. laurifolium Christ. Mekeo District.

N. biserrata Sw. Copel. Phil. Journ. Sc. Bot., vi, 81, 1911. Sogeri; Javararie; Mafulu.

N. dicksonioides Christ. Deva Deva and Mafulu.

Onychium tenue Christ. Copel. Phil. Journ. Sc. Bot.., v, 86, 1911. Laloki River.

Diplazium elongatum Sw. Sogeri.

D. tenerum Forst. Fofofofo.

Anisogonium cordifolium Bedd. (*Diplazium cordifolium* Bl.). Near Fofofofo.

Blechnum orientale L. Beccari in D'Albertis' "New Guinea," 2, 399; F. Muell. Pap. Pl., i (4), 81; Copel. Phil. Journ. Sc. Bot., vi, 84, 1911. Astrolabe Range.

Doryopteris concolor Kuhn. Sapphire Creek.

Cheilanthes tenuifolia Burm. F. Muell. Pap. Pl., 1 (3), 48; Bail. Queens. Agric. Journ., xxiii, 159, 1909; Copel. Phil. Journ. Sc. Bot., vi, 86, 1911.

Hypolepis papuana Bail., Queens. Agric. Journ., xxiii, 158, 1909. Astrolabe Range.

Adiantum lunulatum Burm. F. Muell. Pap. Pl., 1 (3), 49. Javararie.

Pteris longifolia Linn. F. Muell. Pap. Pl., i (1), 16; Copel. Phil. Journ. Sc. Bot., vi, 85, 1911. Port Moresby.

P. orientalis A. v. R. Mafulu.

P. semipinnata Linn. Beccari in D'Albertis' "New Guinea," 2, 399; F. Muell. Pap. Pl., i (4), 78. Dilava.

Histiopteris stipulacea (Hook.) Copel.

Pteridium aquilinum Kuhn., var. **lanuginosum** A. v. R Astrolabe Range and Sogeri (very abundant).

Vittaria angustifolia Bl. Mafulu.

Tænitis blechnoides (Willd.) Sw. F. Muell. Pap. Pl., 2 (6), 22; Copel. Phil. Journ. Sc. Bot., vi, 86, 1911. Deva Deva.

Meniscium triphyllum Sw. Sogeri.

Dictyogramme pinnata J. Sm. (*Syngramma pinnata* J. Sm.). Copel. Phil. Journ. Sc. Bot., vi, 84, 1911. Mekeo District.

Drynaria sparsisora Moore. Copel. Phil. Journ. Sc. Bot., vi, 91, 1911. Laloki River and Sapphire Creek.

D. rigidula (Sw.) Bedd. Copel. Phil. Journ. Sc. Bot., vi, 91, 1911. (*Polypodium rigidulum* Sw., Bail. Queens. Agric. Journ., xxiii, 159, 1909.) Mafulu.

Dipteris conjugata Reinw. (*Polypodium Dipteris* Bl.). F. Muell. Vic. Naturalist, Feb. 1885, and Pap. Pl., 2 (6), 22. Mafulu.

Polypodium nigrescens Bl. Road between Sogeri and Javararie.

Acrostichum aureum L. F. Muell. Pap. Pl., i (4), 76; Copel. Phil. Journ. Sc. Bot., vi, 92, 1911. Yule Island.

A. aureum L., var. **attenuatum** A. v. R. Port Moresby.

GYMNOSPERMÆ.

Family CYCADACEÆ.

Cycas media R. Br. Port Moresby; [Boku, *Mrs. H. P. Schlencker*]. This Cycad is very abundant on the hills about Port Moresby; the leaflets are densely pubescent on the under surface and I have little hesitation in referring it to the very common Australian *C. media*.

C. circinalis Linn. (*C. papuana* F. Muell. Pap. Pl., i (iv), 71; Becc. in D'Albertis' "New Guinea," ii, 399; Bail. Rep.

Visit B.N.G., 27, and Queens. Agric. Journ., xxii, 149.) Mekeo District (also observed but not collected on the road between Sogeri and Javararie).

C. media is a denizen of the dry open forest or grass lands characteristic of a good stretch of the coastal country in Southern Papua, and I have a strong suspicion that the specimens referred to by Bailey l.c. belong to it rather than to *C. circinalis*. However, I cannot find any specimens in the Queensland Herbarium referred to *C. papuana* by him. *C. circinalis* is a very different looking plant and is an inhabitant of the dense rain-forests of the mountains. Schumann and Lauterbach (Fl. Deutsch. Schutz. Gebiete Sudsee, p. 153) place *C. Rumphii* Miquel as a synonym; and as Hooker (Flora British India, v, 657) places *C. Scratchleyanum* as only a form of this, that would leave only two species recorded for the territory of Papua.

Family PINACEÆ.

(Coniferæ.)

Araucaria Cunninghamii Ait. F. Muell. Vic. Nat. iv, 121; Pap. Pl., ii (ix), 65. Mafulu (not very abundant).

MONOCOTYLEDONÆ.

Family PANDANACEÆ.

(Determinations verified by Prof. U. Martelli (Firenze).)

Pandanus Balenii Martelli. Between Sogeri and Javararie.

Freycinetia angustissima Ridl. in Britt. Journ. Bot., xxiv, 359. Bisiatabu (Astrolabe Range).

Family GRAMINEÆ.

(Grasses.)

Coix Lacryma-Jobi Linn. F. v. M. Pap. Pl., i (ii), 31; Becc. in D'Albertis' "New Guinea," ii, 399; Bail. Rep. Visit B.N.G., 28; Queens. Agric. Journ., iii, 162, xxii, 150. Javararie (also noticed at Kabunah).

Polytoca macrophylla Benth. Mt. Warirata and Mafulu.

Dimeria ornithopoda Trin. Bisiatabu (Astrolabe Range). A small grass growing on rocks in exposed situations.

Imperata arundinacea Cyr. F. Muell. Pap. Pl., ii (vi), 20; Vic. Nat., Feb. 1885; Bail. Rep. Visit B.N.G., 28. Astrolabe Range. Common in open forest country almost everywhere; a great pest in coconut plantations.

Saccharum spontaneum Linn. F. Muell. Pap. Pl., i. (iii). 46. Yule Island. My specimens are in a very advanced condition and imperfect, but seem referable to the above.

Miscanthus floridulus Warb. Mafulu.

[**Pollinia grata** Hack. Waigani, *C. N. Loudon*. For the identification of this grass I am indebted to the Director, Royal Botanic Gardens, Kew, England.]

Ischæmum cordatum Hack. Bella Vista.

Apluda mutica Linn. F. Muell. Pap. Pl., i (iii). 46. Port Moresby, Yule Island.

Manisuris granularis Sw. On range between Sogeri and Javararie.

Elionurius citreus Munro. Astrolabe Range.

Ophiuris corymbosus Gærtn. Astrolabe Range.

Heteropogon contortus Rœm. et Schult. Bunch Spear Grass. Bail. Rep. Visit B.N.G., 27; (*Andropogon contortus* Linn.); F. Muell. Pap. Pl., i (iii), 46. Port Moresby.

Andropogon sericeus R. Br. Queensland Blue Grass. Port Moresby; [B. N. Guinea, without precise locality, *G. R. Le Hunte*.]

A. annulatus Forst. Port Moresby.

A. nardus Linn., var. **grandis** Hack. Port Moresby. My specimens of these three species of *Andropogon* are imperfect, and it is desirable that further specimens should be obtained to verify the specific determinations.

Chrysopogon aciculatus Trin. Sogeri.

Sorghum fulvum Beauv. Port Moresby.

Anthistiria imberbis Retz. *A. ciliata* F. Muell. Pap. Pl., i (iii), 47; Bail. Rep. Visit to B.N.G., 27 (*non* Linn.). Port Moresby; Yule Island.

Paspalum scrobiculatum Linn. F. Muell. Pap. Pl., ii (vii), 35; Bail. Rep. Visit B.N.G., 28. Mafulu.

P. longifolium Roxb. (*non* Steud.), now kept by many botanists as distinct from *P. scrobiculatum*, has been recorded by F. Muell. Pap. Pl., i (iv), 74, and by Beccari in D'Albertis' "New Guinea," ii, 399, as from Papua (British New Guinea).

P. distichum Linn., var. **littorale** (R. Br.) Bail. Yule Island.

P. conjugatum Berg. Astrolabe Range; Sogeri; Javararie. A common grass in rubber plantations, sides of roads, &c.

Eriochloa punctata Hamilt. F. Muell. Pap. Pl., i (iv), 74. Port Moresby.

Isachne myosotis Nees. On rocks, Rona Falls (Astrolabe Range); Mafulu.

Panicum sanguinale Linn. F. Muell. Pap. Pl., i (iii), 47 ; Bail. Queens. Agric. Journ., iii, 161 ; Rep. Visit B.N.G., 28. Sogeri.

P. crusgalli Linn. F. Muell. Pap. Pl., ii (vii), 35. Laloki River ; Koitaki (Sogeri District).

P. patens Linn. Bail. Queens. Agric. Journ., xxiii, 219. Astrolabe Range ; Sogeri ; Mafulu.

P. sarmentosum Roxb. Bisiatabu ; Sogeri. Very abundant along forest tracks.

P. indicum Linn. Bella Vista. Rather a slender form.

P. prostratum Lam. Yule Island.

P. plicatum Lam. F. Muell. Pap. Pl., ii (vi), 19 ; Vic. Nat., April 1885. Mafulu.

Arundinella nepalensis Trin. Port Moresby.

Thysanolæna maxima O. Kze. Fairly common on road from Fofofofo to Mafulu.

Setaria glauca Beauv. F. Muell. Pap. Pl., ii (vi), 19 ; Vic. Nat., Feb. 1885. Bella Vista.

Pennisetum macrostachyum Trin. F. Muell Pap. Pl., ii (vi), 19 ; Vic. Nat., Feb. 1885 ; Bail. Queens. Agric. Journ., xxiii, 220. Laloki River.

Cenchrus echinatus Linn. C. T. White, Queens. Agric. Journ., ix, n.s. 180, pl. 14. *Pennisetum cenchroides* Bail. Queens. Agric. Journ., xxiii, 220 (*non* Rich.). Port Moresby ; very common.

Leptaspis urceolata R. Br. F. Muell. Pap. Pl., ii (viii), 57 ; Ridley in Journ. Bot., xxiv, 360. Astrolabe Range.

Eriachne Armitii F. Muell. Hombrom Bluff (Astrolabe Range).

Centotheca lappacea Desv. Bail. Queens. Agric. Journ., ix, 411. Astrolabe Range ; Sogeri ; Javararie. Very common.

Lophatherum gracile Brongn. Hemsley in Kew Bulletin. 1899, 115. Sogeri.

Chloris barbata Sw. Port Moresby.

Eleusine aristata Ehrenb. Port Moresby.

E. indica, Gærtn. F. Muell. Pap. Pl., ii (vi), 20 ; Bail. Rep. Visit B.N.G., 28. Laloki River.

Family PALMACEÆ.

A few specimens of palms collected were sent to the late Dr. Beccari for determination ; unfortunately he did not have time to identify the material before his death. The following species were observed but no specimens collected.

Areca Catechu Linn. Occurs either cultivated or semi-wild practically throughout the territory.

Nipa fruticans Wurmb. Bail. Rep. Visit B.N.G., 28. Common along the Ethel River and its tributaries (Mekeo District).

Metroxylon Rumphii Mart. (*Sagus Rumphii* Willd.) Sago Palm.

Beccari in D'Albertis' "New Guinea," ii, 399, records *M. Rumphii* from the Fly River. Sago palms are common along the coast, and I also saw several along the edges of a small lake below Hombrom Bluff (Astrolabe Range). I did not collect specimens but have placed it under the above species.

Cocos nucifera Linn. Coconut. Extensively planted about villages around the coast.

Family ARACEÆ.

Epipremnum Zippelianum (Schott.) Engl. Becc. Malesia i, 274, tab. xx, pp. 10-12. Diene.

Family FLAGELLARIACEÆ.

Flagellaria indica Linn. F. Muell Pap. Pl. i (iv). 73 ; Rendle in Britt. Journ. Bot., xxiv, 358 ; Bail. Queens. Agric. Journ., iii, 161, and Rep. Visit B.N.G., 28. Dilava ; [Samarai, *W. E. Armit.*]

F. indica, Linn., var. **minor** (Bl.) Hook. f. Bail. Queens. Agric. Journ., xxiii, 219. Port Moresby ; Laloki River ; Mt. Warirata ; Astrolabe Range.

With the Mt. Warirata and Laloki River plant is the following note :—"The common and larger typical *F. indica* also present but not collected."

Family COMMELINACEÆ.

Pollia macrophylla Benth. Deva Deva and Mafulu.

Commelina nudiflora Linn. Mekeo District.

Aneilema nudiflorum R. Br. *Commelina ensifolia* Bail. Queens. Agric. Journ., xxii, 150 (*non* R. Br.). Boku, *Mrs. H. P. Schlencker.*

Mrs. Schlencker's specimens, referred by Bailey l.c. to *C. ensifolia*, I think are more correctly referable to the above.

Forrestia hispida Less. and A. Rich. Fofofofo.

For the determination of this plant I am indebted to Mr. H. N. Ridley, C.M.G., F.R.S.

Cyanotis capitata C. B. Clarke. Ridl. in Journ. Bot., xxiv. 358. Deva Deva.

FAMILY LILIACEÆ.

Rhipogonum papuanum sp. nov.

Frutex alte scandens inermis glaberque ; foliis breviter petiolatis angusto-ellipticis ca. 13-17 cm. longis et 3·5-4·5 cm. latis coriaceis longe et obtusiuscule acuminatis trinervis transversis et valde reticulatis, racemis axillaribus et simplicibus vel terminalibus et paniculatis ; floribus pedicellatis.

A tall glabrous climber, branchlets unarmed. Leaves opposite, sub-opposite, or alternate, narrowly elliptical, tapering at the apex into a rather long blunt point, prominently trinerved and reticulate on both faces ; petiole often twisted, 3-6 lines (·7-1·3 cm.) long ; lamina $4\frac{3}{4}$-$6\frac{3}{4}$ in. (12-17 cm.) long, $1\frac{1}{4}$-$1\frac{3}{4}$ in. (3-4·5 cm.) broad. Racemes in the upper axils, about $1\frac{1}{2}$ in. (4 cm.) long, bearing 2-4 (mostly 4) flowers towards the top ; the upper racemes forming a terminal panicle $2\frac{1}{2}$-6 in. (6·5-15 cm.) long, branches often subtended by a narrow bract, up to $\frac{2}{3}$ in. (1·8 cm.) long ; flowers on slender pedicels of 2-5 lines (·3-1·1 cm.) long. Perianth unknown. Ovary glabrous.

Between Kubunah and Fofofofo.

The specimens are in young fruit only. In many ways it approaches the North Queensland *R. album* R. Br., var. *leptostachya*, from which, however, it differs in its longer more strongly veined leaves. Judging from the description it comes very near *R. Danesii* Domin, but differs from that species in its larger leaves, pedicellated flowers, and in the upper racemes forming a large terminal panicle. The genus has not apparently been previously recorded from New Guinea. There appear to be several forms of *R. album*, perhaps representing distinct species, in Queensland, but the material at my disposal is generally of too fragmentary a nature to base any critical work on.

Dracæna angustifolia Roxb. Becc. in D'Albertis' "New Guinea," ii, 399 ; F. Muell. Pap. Pl., i (iv), 73 ; Ridl. Journ. Bot., xxiv, 357. Astrolabe Range and Sogeri.

Cordyline terminalis Kunth. F. Muell Pap. Pl., i (ii), 30 ; Ridl. Journ. Bot., 24, 358 ; Bail. Rep. Visit B.N.G., 28 ; *Dracæna terminalis* Linn. Becc. in D'Albertis' "New Guinea," ii, 399. Mafulu.

Dianella cærulea Sims. Mt. Warirata.

D. ensifolia Red. F. Muell Pap. Pl., i (vi), 17; Ridl. Journ. Bot., 24, 358; F. Muell. Austr. Scientific Magazine, Oct. 1885; *D. nemorosa* Lam.; Hemsl. Kew Bulletin, 1899, 113. Mafulu.

FAMILY MUSACEÆ.

(H. N. Ridley, C.M.G., M.A., F.R.S.)

Heliconia Micholtzi Ridl. Sogeri (No. 826).

FAMILY ZINGIBERACEÆ.

(H. N. Ridley, C.M.G., M.A., F.R.S.)

Riedelia Whitei Ridl. (n. sp.).

Planta glabra gracilis ultra 30 cm. alta. Folia lanceolata acuminata basi longe angustata 18 cm. longa 3 cm. lata, petiolo gracili 2 cm. longa, ligula brevis glabra truncata 2 mm. longa vagina 6 cm. longa striolata haud cancellata. Racemus simplex 5 cm. longus vel ultra, decurvus terminalis, floribus ad 12 pedicellis 2 mm. longis. Calyx tubulosus cylindricus 15 mm. longus, ore obliquo lamina ovali. Corollæ tubus æquilongus, lobus superior elongata 7 mm. longus lanceolata acuminata in acumine longo, laterales multobreviores lineari oblonga 5 mm. longus. Labellum brevius, bifidus lobis lanceolatis acuminatis. Capsula oblongo elliptica rubra bilocularis in valvis 2 deh scens 1 cm. longa, 5 mm. crassa. Semina plurima aurantiaca.

Deva Deva (White, 655, 613).

Only one flower in moderate condition unfortunately, and that with the stamen decayed. The upper corolla-lobe has a peculiarly long acuminate point. The fruiting specimen No. 613 probably is of the same species. The fruits are peculiar from their dehiscing in 2 valves leaving a mass of very small-angled seeds in the centre.

Hornstedtia lycostoma Schum. Sogeri. 405.

Bracts red on edges, white-spotted on general ground area, white at base.

Riedelia lanatiligulata Ridl. (n. sp.).

Caulis validus 2 cm. crassus. Folia lineari-lanceolata acuminata basi angustata; superne hirtula; subtus molliter hirta margine sericea 60 cm. longa 9·5 cm. lata; petiolo canaliculato 8 cm. longa, vaginis cancellates hirtis vel subglabrescens, ligula maxima ovata 6-7 cm. longa 2 cm. lata dense longo-lanuginosa. Panicula lateralis valida ; ramis 3 multi floris 13 cm. longis. Bracteæ ad bases ramorum lineari-lanceolatæ papyraceæ 15 cm. longæ 1·5 cm. latæ. Flores subsessiles glabri. Bracteola calyciformis tubulosa costata ad basin angustata breviter tridentata ; 10 mm. longa. Calyx 17 mm. longa cylindrica costata, in uno latere fissa, dentibus 2, acuminatis. Petala angusta linearia, tubo calyce æquilongo. Labellum profunde bifidum in lobis linearibus 2. Stylus filiformis ad apice gradatim incrassatis, stigmate obconico.

Near Fofofofo (No. 615).

This species is very distinct in its hairy leaves and very large woolly ligule, and is apparently a very robust plant. Unfortunately the few buds which are left on the specimen are in a very rotten condition.

Tapeinocheilos pubescens Ridl., Journ. Bot., xxiv, 356. Sogeri (No. 313).

Costus speciosus Sm. var. **argyrophyllus** Wall. Sogeri (No. 414). Flowers white ; apparently identical with *C. Lamingtonii* Bail.

Eriolopha ovalifolia Ridl. (n. sp.).

Caulis 62 cm. longæ. Folia ovata acuminata rigida, basi rotundata 9 cm. longa 3 cm. lata, petiolo 4 mm. longo, vagina 3 cm. longa cancellata ligula brevi 3 mm. longa cum marginibus vaginæ pubescenti. Racemus terminalis simplex 13 cm. longus velutino-pubescens. Bractea ad basin linearis lanceolata acuminata 8 cm. longa 5 mm. lata glabra. Pedicelli 3 mm. longi velutini ad 14. Calyx tubulosa 14 mm. longæ cylindrica lamina ovata pubescens. Corolla tubo calyce æquante. Petalum superius oblongum-ovatum obtusum cucullatum 5 mm. longum pubescens, lateralia angustiora pubescentia obtusa. Labellum multibrevius bifidus ad medium, lobis ala tenui rotundata exteriore, nitus processu lineari-obtuso incrassato. Anthera glabra oblonga truncata retusa, crista nulla stylus gracilis glaber. Stilidia minuta.

Deva Deva (White, 656).

This species is peculiar in its ovate rigid leaves and apparently complete absence of anther-crest, in spite of which it appears to be in other respects an *Eriolopha*. The stamen is notched at the top, the anther-cells projecting as two short points. The lip is as usual very small, and deeply bifid, each lobe consisting of a thin outer rounded wing while the inner edge is more fleshy and prolonged into a short blunt point.

Owing to the poorness of the material to hand several other specimens of Zingiberaceæ could not be specifically determined.

Family MARANTACEÆ.

(H. N. Ridley, C.M.G., M.A., F.R.S.)

Donax cannæformis Ridl. Sogeri. Common all over the eastern islands.

Cominsia Guppyi Hemsl. Between Sogeri and Javararie. I am inclined to agree with Schumann that *Cominsia Guppyi* Hemsl. and *C. gigantea* are the same species.

Phrynium capitatum Willd. Sogeri. A common plant. In fruit only. The species is recorded from India, Cochin China, China, and Java, but I am doubtful as to whether the Malay plant is not distinct from the Indian one.

Phacelophrynium Whitei Ridl. (n. sp.)

Caules gracilis 30 cm. longis vel ultra. Folium lanceolatum acuminatum basi subacuto subinæquilaterum 24 cm. longum. 7·5 cm. latum petiolo 10 cm. longo. Pedunculus 10 cm. longus gracilis panicula 6 cm. longa ; ramis paucis congestis. Bracteæ lanceolatæ siccæ 8 mm. longa, vel minora. Flores parvi verosimiliter albi, pedicellis 2 mm. longis ad 1 cm. crescentibus. Ovarium oblongum pubescens 1 mm. longum. Sepala 3 mm. longa late lanceolata acuminata. Corolla tubo sepalis æquilongo lobis late oblongis obtusis, recurvis. Labellum obovatum rotundatum, integrum. Anthera linearis.

Mekeo District (807).

A small-sized plant with a short many-spiked dense panicle. The whole flower 1 cm. long. Allied to an undescribed Borneo species. Though the inflorescence in these plants is much smaller than in typical *Phacelophrynium*, I think that as far as its structure goes it is best to keep them in this genus.

The collection also includes specimens of some other Marantaceæ which owing to poorness of material could not be specifically determined.

Monophrynium sp. Mafulu (420). A fruiting specimen of a large plant with broad cut-up leaves as in *Phrynium fissifolium* Ridl. The fruit resembles that of *Monophrynium fasciculatum* Schum., but is less acutely angled. The specimen is too incomplete (all the bracts having fallen) to describe adequately, but it is evidently an undescribed plant allied to *Monophrynium* and *Cominsia*.

Phacelophrynium sp.

Caules graciles 60 cm. alti. Folium lineari-oblongum; valdevenosum costa alte elevata basi cuneato 32 cm. longum 6 cm. latum, petiolo 18 cm. longo. Panicula brevis 8 cm. longa, pauce ramosa. Bracteæ tenuiter papyracea lanceolata acuminata 3 cm. longa 5 mm. lata. Flores non visi. Panicula fructifera ramis validulis 4 cm. longa 5 cm. lata. Capsula obtuse triquetra globosa 1 cm. longa et lata.

Deva Deva (632); Central Division (825).

This species is notable for the prominence of the nerves, especially on the back of the leaf when dry, and the small size of the few-branched panicle with the thin lanceolate brown bracts.

The collection also contains another more typical *Phacelophrynium* with large leaves and a panicle of 3 branches 15 cm. long of distichous stout bracts 3-4 cm. long, 2 cm. wide, in which are smooth, polished, yellow, triquetrous capsules 1·5 cm. long in pairs on very short peduncles. It is to be hoped that complete specimens of this fine plant may be obtained. Sogeri (No. 406).

Family ORCHIDACEÆ.

A complete account of the Orchidaceæ collected has already been published under the joint authorship of Dr. R. S. Rogers, M.A., and myself in the "Transactions and Proceedings of the Royal Society of South Australia," vol. xliv, pp. 110-119, plates v-viii.

DICOTYLEDONEÆ.

Family CASUARINACEÆ.

Casuarina nodiflora G. Forst. F. Muell. Pap. Pl., ii (vi), 6. Astrolabe Range and Mafulu District. A very common tree in the first-mentioned locality.

C. equisetifolia R. & G. Forst. F. Muell. Pap. Pl., i (i) 12; Bail. Rep. Visit B.N.G., 28, and Queens. Agric. Journ., xxii, 149; Foxworthy Ann. Rep. Papua, 1909-10, 114. I did not see this growing wild, but there is a fine avenue of these trees planted along the esplanade road at Port Moresby.

Family PIPERACEÆ.

Piper miniatum Bl. Bisiatabu. A climbing Pepper with long red fruiting-spikes.

Family FAGACEÆ.

(Order Cupuliferæ.)

Quercus sp. Deva Deva.

Castanopsis Schlenckeræ Bail., Queens. Agric. Journ., xxii, 149. Mafulu. Large tree, dense foliage, common.

Family ULMACEÆ.

Trema virgata Bl., var. **scabra** Bl. Lauterbach Beitr. Fl. Pap., iii, 312; (*T. cannabina* F. Muell. Pap. Pl., i (iii), 40; *T. aspera* Bl., var. *viridis* (Bl.) Benth.). Port Moresby.

Family MORACEÆ.

Fatoua japonica Bl. Yule Island; Port Moresby, *E. Cowley*.

Cudrania javanensis Trécul. Laloki River.

Artocarpus incisa Forst. Becc. in D'Albertis' "New Guinea," ii, 398; Bail. Rep. Visit B.N.G., 27. Port Moresby; Laloki River; Mekeo District; Yule Island. Not collected, but common wild or cultivated through the whole of the coastal country.

Ficus infectoria Roxb. Sapphire Creek.

F. Rigo Bail., Queens. Agric. Journ., i, 235. Yule Island. A handsome tree, much planted about Port Moresby.

F. retusa Linn. Yule Island. For ornamental planting this tree is one of the very best of the Figs, having a great spread of dense dark-green foliage.

[**F. fistulosa** Reinw. Ambasi, *Rev. Copland King*; S.E. New Guinea, *H. O. Forbes* (ex Nat. Herb. Melb.); Sogeri, *H. O. Forbes* (ex Nat. Herb. Melb.)]

F. myriocarpa Miq. Javararie.

It is with some hesitation that I refer these specimens to *F. myriocarpa*; the leaves are densely hirsute but scarcely hispid and certainly not hispid on both surfaces. The identification wants confirming with better material.

Family URTICACEÆ.

Elatostemma lineolatum Wight, var. **integrifolium** Hook. Between Sogeri and Javararie ; Dilava ; Mafulu.

E. sesquifolium Hassk. Bisiatabu (Astrolabe Range). A form with the leaves pubescent on both upper and lower surfaces.

E. sessile Forst. Dilava.

My collection also contains several other species of *Elatostemma*, but in too bad a state for determination.

Pouzolzia hirta Hassk. (*P. quinquenervis* Benn.). F. Muell. Pap. Pl., i (iii), 40. Mafulu.

Pipturus incanus (Bl.) Wedd. (*P. velutinus* Wedd.) Becc. in D'Albertis' "New Guinea," ii, 398 ; F. Muell. Pap. Pl., i (iv), 60 ; (*P. argenteus* Bail., Queens. Agric. Journ., xxiii, 219 (*non* Willd.)). Port Moresby.

I follow Mueller and others in keeping the Papuan plant as *P. incanus;* in general appearance, however, it can hardly be distinguished from the common Australian *P. argenteus*. All my specimens and Mrs. Schlencker's, referred to *P. argenteus* by Bailey l.c., are slightly scabrid on the upper surface of the leaves.

Leucosyke capitellata Wedd. Dilava.

Family PROTEACEÆ.

Grevillea pinnatifida Bail., Occasional Papers on the Queensland Flora, 6 (1886) ; *G. Edelfeldtiana* (name only) F. M. in Vic. Nat., Feb. 1885, and Pap. Pl., 2 (vi), 9 ; Lauterbach, Beitrage zur Flora Papuasien, iii, 329. Astrolabe Range (very abundant).

This tree is very abundant on the Astrolabe Range and averages 30-40 ft. high. I was unable, however, to gather either flowers or fruits, and Mueller named his *G. Edelfeldtiana* from leaves only. The leaves, however, are exactly those of the North Queensland *G. pinnatifida*, and consequently I have reduced Mueller's name to a synonym. Mueller's name had a year's priority over Bailey's, but as it was unaccompanied by a description of any sort it should lapse in favour of the latter. I am indebted to Prof. A. J. Ewart for having compared my Papuan material with Mueller's type in the National Herbarium at Melbourne.

G. subargentea sp. nov.

Arbor mediocris, ramulis junioribus sericeo-pubescentibus ; foliis junioribus ca. 30·5 cm. longis alte 3-5 lobatis, lobis 1·2-2·5 cm. latis, subtus sericeo-pubescentibus ; foliis maturis integris vel breviter lobatis, lanceolatis vel falcato-lanceolatis, subtus sericeo-pubescentibus utrinque reticulatis subtriplinervis racemis ca. 16·5 cm. longis ; floribus ignotis ; fructu ellipsoideo, ca. 2·5 cm. longo.

A medium-sized tree, the very young parts clothed with white appressed hairs. Leaves on coppice shoots or young trees deeply pinnatifid into 3-5 lobes, about 1 ft. (30·5 cm.) long, the individual lobes $\frac{1}{2}$-1 in. (1·2-2·5 cm.) broad ; adult foliage entire or slightly lobed, lanceolate, sometimes somewhat falcate, tapering at the base into a petiole of 6-8 in. (15-20 cm.) long, varying in width from 1-2$\frac{3}{4}$ in. (2·5-7 cm.), under surface silky pubescent ; both faces in the dried specimens prominently reticulate with very oblique veins and veinlets, a pair of secondary veins running parallel with the midrib about half-way between it and the edge of the leaf. Racemes (only seen in fruit) up to 6$\frac{1}{2}$ in. (16·5 cm.) long. Flowers unknown. Follicle woody, ellipsoid, slightly compressed, not stipitate, 1 in. (2·5 cm.) long, 7-8 lines (1·5-1·8 cm.) broad on a pedicel of 2 lines (5 mm.).

Deva Deva (Nos. 643 and 653).

In systematic position this species comes between the East Australian *G. pinnatifida* and *G. Hilliana.*

[**G. densiflora** sp. nov.

Arbor, ramulis robustis ; foliis petiolatis, petiolo pubescente, lanceolatis vel obovato-lanceolatis supra glabrescentibus, subtus minute lepidotis, nervis lateralibus circiter 20 ante marginem conjunctis, juxta marginem nervo altero marginati unitis ; racemis simplicibus axillaribus densifloris cum pedicellis et floribus ferrugineo-pubescentibus ; pistilo glabro ovario stipitato.

A tree, branchlets stout. Leaves petiolate, petiole about 8 lines (1·7 cm.) long, clothed with an appressed pubescence ; blade 4$\frac{1}{2}$-8$\frac{1}{2}$ in. (11·5-30·7 cm.) long, about 2 in. (5 cm.) wide, lanceolate or obovate-lanceolate, upper surface glabrescent, under surface densely covered with minute gland-like scales, both faces reticulate ; the midrib and main nerves prominent, main lateral nerves about 20 on each side of the midrib, about 1-1$\frac{1}{2}$ line (2-3 mm.) from the margin arching into a prominent intramarginal vein. Racemes very densely flowered, about as long as the leaves, rhachis densely pubescent with appressed somewhat strigose hairs. Pedicels 3-4 lines (6-9 mm.) long, pubescent with somewhat strigose hairs. Perianth segments 4 lines (9 mm.) long, clothed on the outer surface with appressed strigose hairs. Pistil glabrous; ovary stipitate on a gynophore 1½ line (3 mm.). Fruit not seen.

Boku, British New Guinea, *Mrs. H. P. Schlencker.*

This new species is quite unlike any other Papuan or Australian *Grevillea* known to me. The specimens were collected by Mrs. Schlencker in 1909 and referred by the late F. M. Bailey as near *Finschia rufa* Warbg. It may, when the fruit is known, prove a species of *Finschia*, but it differs from *F. rufa* and *F. chloroxantha*, the only known members of the genus.]

Helicia validinervis sp. nov.

Arbor, ramulis glabris; foliis petiolatis lanceolatis sensim longe acuminatis integris utrinque glabris reticulatis nervis subtus prominentibus; racemis laxifloris rhachide pubescente; floribus geminatum pedicellatis pedicello dense pubescente; perianthii segmentis ferrugineo-pubescentibus; ovario hirsuto, stylo glabro.

A tree, branchlets glabrous, finely striate. Leaves distinctly petiolate, petiole ½-1 in. (1·3-2·5 cm.); blade lanceolate, tapering at the apex into a long acuminate point, 7-11½ in. (18-29 cm.) long, glabrous, green on both faces, strongly nerved, main nerves prominently raised on the under surface, reticulations distinct between them, margins entire. Racemes shorter than the leaves, about 7 in. (18 cm.) long, rhachis clothed with rather long, scattered, ferruginous hairs. Flowers on pedicels of about 1 line (2 mm.); pedicels and perianth segments ferruginous-pubescent, ovary densely clothed with long villous hairs.

Mekeo District.

Among previously recorded Papuan species *H. validinervis* approaches very closely to *H. toricellensis* Laut., which differs from it in its smaller leaves insensibly tapering at the base into a petiole. From *H. Forbesiana* it differs in its larger flowers and smaller less prominently veined leaves. Lauterbach's key to the Papuan species of *Helicia* (Beiträge zur Flora von Papuasien, iii, 330) places *H. Forbesiana* among those with a glabrous rhachis, whereas specimens from the National Herbarium, Melbourne, and collected by Forbes, show the rhachis to be clothed with scattered ferruginous hairs.

H. latifolia sp. nov.

Arbor, ramulis lenticellatis; foliis utrinque glabris prominule reticulatis supra nitidis late lanceolatis vel elliptico lanceolatis integris breviter petiolatis, petiolis incrassatis; racemis laxifloris, floribus pedicellatis, pedicellis ferrugineo-pubescentibus; perianthii segmentis 9 mm. longis fere glabris; pistillo glabro.

A tree, branchlets lenticellate. Leaves shortly petiolate, petiole stout, 1-3 lines (2-6 mm.) long; blade broadly lanceolate, glabrous on both sides, veins and reticulations fairly prominent, upper surface rather glossy, apex bluntly acuminate, 5-8 in. (13-10·7 cm.) long, $2\frac{1}{2}$-$4\frac{1}{4}$ in. (6·5-11 cm.) broad, margins entire. Racemes about as long as or longer than the leaves; rhachis clothed with a few ferruginous hairs. Flowers in pairs but pedicels distinct to the base, pedicels $1\frac{1}{2}$-2 lines (3-4 mm.) long, thinly ferruginous-pubescent. Perianth 4 lines (9 mm.) long, glabrous except for a few brown hairs on the outer surface. Ovary and style glabrous.

Deva Deva.

Amongst previously recorded Papuan species *Helicia latifolia* approaches most closely to *H. moluccana*, which differs in its quite glabrous inflorescence and narrower leaves.

Banksia dentata Linn. f. F. Muell. Pap. Pl. (ii), 28; Beccari in D'Albertis' "New Guinea," 2, 398; Lauterbach in "Beiträge zur Flora von Papuasien," iii, 334. Astrolabe Range (very common).

Family LORANTHACEÆ.

(By W. F. Blakely, Botanical Assistant, National Herbarium, Sydney.)

Loranthus L.

Subgenus I.—Euloranthus Engl.

Section I.—Dactyliophora van Tiegh.

Series I.—Euamyema Engl.—B. Cymulati.

Loranthus barbellatus Blakely n. sp.

Glaber; ramis robustis nodis subtumidis; foliis oppositis late spathulatis; vel ellipticis, petiolatis, coriaceis, 5-7 nerviis, 3-9 cm. longis, 2-5 cm. latis; cymis interaxillaribus, foliis brevioribus, 3-6 ramis; floribus in triadibus, intermediis sessilibus; pedunculo communi tenue, 15 mm. longo; pedicellis 5-7 mm. longis; calyce lato cupulare irregulariter denticulato;

alabastris cylindraceis 25 mm. longis; petalis liberis 5-6 apice barbatis; antheris linearibus adnatis 4 mm. longis, fructus non vidimis.

Glabrous shrubs, branches rather stout, nodes somewhat prominent or swollen; leaves opposite, broad spathulate to broadly elliptical, undulate, tapering into a short stout petiole, 6-9 cm. long, 2-5 cm. broad, somewhat coriaceous, 5-7-nerved, the second pair confluent with the median nerve 1-3 cm. from the base, the upper portion branched, spreading, flexuose or looped. Cymes internodous, single or in pairs, shorter than the leaves; common peduncle slender, 15 mm. long, 3-6-branched; flowers arranged in triads, the middle one of each triad sessile, the two lateral on short pedicels. Bracts broad lanceolate, concave acute, 2 mm. long, minutely ciliate at the apex, shorter than the calyx. Calyx broadly cupular, irregularly denticulate. Buds slender, cylindrical, 25 mm. long; petals 5-6, free, narrow-lanceolate, bearded on the inside with a tuft of red-brown semi-deciduous hairs. Filaments narrow, 4-5 mm. long; anthers adnate, linear, 4 mm. long. Style angular, broader towards the base, 27 mm. long; stigma small, capitate. Disc prominent. Fruit not seen.

Astrolabe Range, on *Eucalyptus* (No. 231).

As far as I am aware this species does not appear to answer the description of any previously described species, and I therefore propose the name *L. barbellatus* on account of the petals being bearded inside at the apex. Its nearest affinity is *L. queenslandicus* Blakely MSS., from which it differs in the more strongly marked venation and undulate leaves, different shaped calyx, bracts, and relatively smaller and finer pedicels, also in the domed disc. The filaments of *L. queenslandicus* are twice the length of the anthers, those of *L. barbellatus* are about the same length. The inflorescence, the only one I saw *in situ*, is internodous. Whether this is a constant character remains to be proved, as I have not seen it in any of the Australian species investigated by me. This species resembles somewhat *L. novæ-guinæ* Bail. in the foliage, but the inflorescence is not the same.

Subgenus II.—DENDROPHTHŒ Mart.

L. odontocalyx F. v. M., var **propria** Blakely var nov.

Vestimentum surculorum juvenilium atque inflorescentiæ minute rufro-cinereum. Folia macro plerumque late lanceolata, 5-10 cm. longa, 2-5 cm. lata, petiolata; petiolæ 1-2 cm. longæ.

Vestiture of the young shoot and the inflorescence minutely rufous-hoary. Leaves thin, usually broad-lanceolate, 5-10 cm. long, 2-5 cm. broad, petiolate; petioles 1-2 cm. long. Inflorescence and structure of the flowers the same as *L. odontocalyx*, but the calyx is often entire, sometimes split on one side, and minutely and irregularly toothed.

Yule Island, on *Inocarpus edulis*, "Corolla tube yellow; lobes red." (No. 736.)

This variety is intermediate between *L. odontocalyx* F. v. M. and *L. vitellinus* F. v. M. It has some of the characters of both, and yet dissimilar. The typical *L. odontocalyx* has a hoary vestiture, whilst the vestiture of *L. vitellinus* is ferruginous tomentose. That of the new variety is partly both.

II.—VISCOIDEÆ.

Viscum.

Section I.—Ploinixia Korth.

Series I.—Isanthemum van Tiegh.

Viscum verruculosum Wight et Arn. in Fl. Ind. Ori., i, 279. Yule Island (No. 720). Fruit immature, cylindrical, contracted at the base, prominently verrucose.

This specimen agrees somewhat with *V. orientale* Willd., as figured in Blume's Flora Java, t. 24, but it is more applicable to the description of *V. verruculosum*, especially in the shape and character of the fruits, as will be seen presently. J. D. Hooker, in Flora British India, v, 224, describes the fruits of *V. orientale* Willd. as "globose, smooth." Kurz. in Forest Flora, British Burma, ii, 324, states that they are "globular, the size of a pea." Wight in Illustrations of Indian Botany, p. 68, pl. 122, depicts a smooth elliptical fruit, while in his Fl. Ind. Ori. l.c. he describes the fruits as "(purple) somewhat globose, copiously and minutely dotted." In the same work the fruits of *V. verruculosum* are described thus:—"Berries (very immature) linear-oblong, covered with little warts."

There is a footnote which runs—"Dr. Wight made the following memorandum when he collected the specimen: Fruit long, slender, warty, lateral ones of each fascicle cernuous, leaves and plant very like *V. orientale*, of which it is perhaps a variety. Keeble in the Loranthaceæ of Ceylon, Trans. Linn. Soc. Lond., 2nd ser., Botany, vol. v, pt. iii, p. 115 (1896), describes the fruits of *V. orientale* as "small green, somewhat lenticular with oval outline."

Trimen in Handbook Flora Ceylon, iii, 471, is inclined to the opinion that the Ceylon plant which has "much warted fruits" is *V. verruculosum* W. & A.

It appears to me that further investigation will prove this to be a valid species. The new locality is an extension to its previously known range, and the species is an addition to the Flora of New Guinea.

Section II.—Aspidixia Korth.

V. angulatum Heyne. Astrolabe Range (No. 344).

As far as I am aware this species has not been recorded previously for the mainland of New Guinea. It has an extensive Oceanic range, extending from India to the Philippine Islands, New Guinea, Thursday Island, Prince of Wales Island, and thence to Australia.

Family SANTALACEÆ.

Exocarpus latifolia R. Br. F. Muell. Pap. Pl., 1 (1), 10. Port Moresby.

Family OLACACEÆ.

Opilia amentacea Roxb. F. Muell. Pap. Pl., i (iv), 53. Yule Island.

Cardiopteris moluccana Blume. *C. lobata* Bail. Queens. Agric. Journ., xxiv, 20 (*non* R. Br.). Yule Island.

Family ARISTOLOCHIACEÆ.

Aristolochia Tagala Cham. Sogeri.

My specimens are in fruit only but agree well with specimens of this Philippine plant received from the Bureau of Science, Manila, P.I.

Family POLYGONACEÆ.

Polygonum barbatum Linn. F. Muell. Pap. Pl., i (iv), 58. Sogeri. A glabrescent form.

P. chinense Linn. Hemsl. Kew Bulletin, 1899, 108. Mafulu.

P. alatum Buch., var. **nepalense** Hook. f. Bella Vista (about 5,000 feet).

Family AMARANTACEÆ.

Amarantus viridis L. Port Moresby. A common weed.

Cyathula prostrata Blume. (*C. geniculata* Lour). Javararie.

Family CARYOPHYLLACEÆ.

Drymaria diandra Bl. F. Muell. Pap. Pl., i (v), 86. Javararie. A common weed along damp plantation tracks.

Family RANUNCULACEÆ.

Clematis Pickeringii A. Gr. Sogeri.

Family ANONACEÆ.

[**Uvaria purpurea** (Bl.) var. **neoguineensis** (Engl.) Diels. (*U. neoguineensis* Engl.) Boku, *Mrs. H. P. Schlencker.*]

Eupomatia laurina R. Br. F. Muell. Pap. Pl., ii (vii), 26. Astrolabe Range.

Several other Anonaceæ were collected, but as they are in fruit only it is impossible to trace the species down; there are also several other Papuan Anonaceæ in the Queensland Herbarium in like condition.

Family MYRISTICACEÆ.

Myristica subalulata Miq. Warb. Monogr. Myristic., 486. Sogeri District; Mafulu.

Family LAURACEÆ.

Litsea calophyllantha K. Sch. Dilava.

My specimens are in fruit only but the leaves agree well with specimens collected by Dr. Karl Weinland. The fruits (not previously described) are—Elliptic, about 1 in. (2·5 cm.) long and ½ in. (1·2 cm.) long, seated on the slightly enlarged calyx.

Cryptocarya triplinervis R. Br. Yule Island.

Differs from the typical Australian *C. triplinervis* in the under surface of the leaves only being thinly pubescent with tufts of hairs in the axils of the primary veins. Some North Queensland specimens are inclined to be glabrescent but not to so marked a degree as the Papuan plant. My specimens are in fruit only and when better known the Papuan plant may be found worthy of varietal or even specific distinction.

Cassytha pubescens R. Br. Port Moresby.

My specimens are more or less densely pubescent, even on the older stems.

[**C. filiformis.** British New Guinea—without precise locality, Sir Wm. Macgregor.]

In addition to the above my Lauraceæ material includes three species of *Cinnamomum* in leaf only; one of these—a large tree from Sogeri—possesses a bark with a very strong cinnamon-like odour.

Family CAPPARIDACEÆ.

Polanisia viscosa DC. F. Muell. Pap. Pl., i (iv), 52; Bail. Rep. Visit B.N.G., 27. Port Moresby.

Capparis umbellata R. Br. Port Moresby; Yule Island.

C. quiniflora DC. F. Muell. Pap. Pl., i (i), 5; Lauterbach Beitr. Fl. Pap., iv, 112. Port Moresby.

C. lucida R. Br. Port Moresby.

Mueller has recorded *C. nobilis* as a Papuan plant, and my collections include two other species, but both too fragmentary to name specifically.

Family NEPENTHACEÆ.

Nepenthes Kennedyana F. Muell. F. Muell. Pap. Pl., i (ii), 20; Bail. Rep. Visit B.N.G., 28; Bail. Queens. Agric. Journ., xxii, 148 Astrolabe Range. A climber in swampy ground round edge of a small lake below Hombrom Bluff.

My specimens bear male flowers only; the spikes are more slender and the flowers not so crowded as in the typical plant; it may when fruit are available prove distinct. Mrs. Schlencker's specimens referred to by Bailey l.c. are in fruit and typical.

N. Moorei Bail. Astrolabe Range. Very common in dry open forest country near Bisiatabu. The specimens seem to agree well with the Australian plant.

Family PITTOSPORACEÆ.

Pittosporum ferrugineum Ait. F. Muell. Pap. Pl., ii (vi), 4; Vic. Nat. April 1885; Bail. Queens. Agric. Journ., ix, 410. Mafulu.

Family ROSACEÆ.

Rubus moluccanus Linn. Hemsley Kew Bull. 1899, 99; Bail. Queens. Agric. Journ., xxii, 148, and xxiii, 220. Astrolabe Range and Mafulu.

R. rosæfolius Sm. Hemsley Kew Bull. 1899, 99; F. Muell. Pap. Pl., ii (vii), 29; Bail. Queens. Agric. Journ., xxiii, 220. Astrolabe Range and Mafulu.

Family LEGUMINOSÆ.

Albizzia procera Benth. Bail. Rep. Visit B.N.G., 28. Port Moresby. A very common tree.

Acacia farnesiana Willd. Port Moresby. Fairly common, perhaps naturalised.

A. auriculæformis A. Cunn. Port Moresby. Fairly common.

Afzelia bijuga A. Gray. Bail. Queens. Agric. Journ., vii, 348. Laloki River; Yule Island. The timber, locally known as "Melila," is the principal hardwood of the territory.

Bauhinia sp. Port Moresby. A scrambling shrub; leaflets free to the base, obliquely oblong, about 1½ in. (4 cm.) long and about 1 in. (2·5 cm.) broad. Pods thick and woody. Probably represents a new species but the flowers are unknown.

Cassia alata Linn. Ringworm Bush. Naturalised and very common about Port Moresby.

Cæsalpinia Bonducella Roxb. Port Moresby. It is recorded by Mueller in Pap. Pl., i (iii), 43, from Darnley Island. This, however, is Queensland territory.

C. nuga Ait. Bail. Rep. Visit B.N.G., 28; Proc. Roy. Soc. Queens., xviii, 1. Yule Island.

Crotalaria juncea Linn. F. Muell. Pap. Pl., i (iv), 61. Port Moresby.

C. linifolia Linn. f. F. Muell. Pap. Pl., i (iii), 42; Bail. Rep. Visit B.N.G., 27. Port Moresby.

C. calycina Schranck. Sapphire Creek.

C. striata DC. Port Moresby.

I saw this plant growing about the town but omitted to gather specimens.

Psoralea badocana (Blanco) Benth. Port Moresby; Yule Island. This rather pretty blue-flowered plant is very abundant at the localities mentioned.

Indigofera linifolia Retz. F. Muell. Pap. Pl., i (iii), 42. Yule Island.

I. enneaphylla Linn. F. Muell. Pap. Pl., i (iv), 61. Port Moresby.

I. trifoliata Linn. F. Muell. Pap. Pl., i (iii), 42. Sapphire Creek.

I. viscosa Lam. F. Muell. Pap. Pl., i (iv), 61. Port Moresby.

Tephrosia vestita Vog. Sapphire Creek and Astrolabe Range.

T. astragaloides R. Br. *T. vestita* Bail. Queens. Agric. Journ., xxiii, 218 (*non* Vogel). Port Moresby.

A very common plant about Port Moresby. The flowers are whitish or with a faint purplish tinge and are borne in elongated racemes. The leaves are silky above, hence the Papuan plant would go under the variety (?) *macrostachya* Benth.; this variety, however, does not seem a very well-marked one. The specimen referred to by Bailey l.c. as *T. vestita* belongs here.

Sesbania aculeata Pers. F. Muell. Pap. Pl., i (iv), 62. Port Moresby.

Stylosanthes mucronata Willd. Port Moresby.

Very abundant in the streets and roads of the town area; probably introduced. In North Queensland this plant has attracted considerable attention as a fodder.

Desmodium umbellatum DC. F. Muell. Pap. Pl., i (iii), 42. Port Moresby (very common).

D. pulchellum Benth. F. Muell. Vic. Nat. Feb. 1885; Pap. Pl., ii (vi), 7. Sapphire Creek and Astrolabe Range.

D. gangeticum DC. F. Muell. Pap. Pl., i (v), 88. Sapphire Creek; Yule Island.

D. parvifolium DC. Sapphire Creek.

D. Scalpe DC. Mafulu.

D. triquetrum DC. F. Muell. Pap. Pl., ii (vi), 7. Astrolabe Range.

D. papuanum n. sp.

Fruticosa erecta, ramulis griseo-pubescentibus; foliis petiolatis, unifoliolatis vel raro trifoliolatis, foliolis oblongis utrinque pubescentibus, terminali maximo, lateralibus duplo vel triplo brevioribus; racemis terminalibus, rhachide pedicillisque ferrugineo-pubescentibus, floribus violaceis; bracteis late lanceolatis acuminatis striatis pubescentibus; leguminibus ferrugineo-pubescentibus, articulis 7-9.

An erect branching shrub about 3 ft. (1 m.) high. Branches woody, clothed with grey hairs, young branchlets densely so. Leaves usually 1-foliolate, sometimes 3-foliolate; petiole about $\frac{3}{4}$ in. (2 cm.) long, grey-pubescent; leaflets oblong, clothed on both faces with long silky hairs, particularly the under surface; single or end leaflet 1-1$\frac{1}{2}$ in. (2·5-4 cm.) long, $\frac{1}{2}$-$\frac{3}{4}$ in. (1·4-2 cm.) broad; side leaflets when present much smaller, about $\frac{1}{2}$ in. (1·4 cm.) long and $\frac{1}{4}$ in. (7 mm.) broad; stipules 4 lines (9 mm.) long, silky-pubescent. Racemes terminal, 1-1$\frac{1}{2}$ in. (2·5-3·8 cm.) long, rhachis closely and densely ferruginous-pubescent; bracts hirsute with yellow hairs, broadly lanceolate, acutely acuminate, closely striate, about 5 lines (1·1 cm.) long and 2 lines (4 mm.) broad. Flowers blue-violet; pedicels ferruginous-pubescent. 2-3 lines (4-7 mm.) long; calyx about 1 line long; standard 5 lines (1·1 cm.) across; wings and keel each 4 lines (9 mm.) long; ovary densely clothed with long white hairs. Pod about 1 in. (2·5 cm.) long, of 7-9 articles, ferruginous-pubescent with spreading hairs.

Astrolabe Range [Stephansort, bei Erima am Strande, *Lewandowsky* n. 62 am 20 Aug. 1899.]

Closely allied to *D. polycarpum* from which it is easily distinguishable by several features, as for instance its usually 1-foliolate leaves, pubescent non-striate stipules, more generally pubescent character, larger flowers, and larger ferruginous-pubescent pods. Lewandowsky's plant (referred by Schumann and Lauterbach in "Die Flora der Deutsche-Schutzgebiete in der Südsee" to *D. polycarpum*) I would refer here.

Alysicarpus vaginalis DC. Port Moresby (with oblong leaves); Yule Island (a form with very narrow-lanceolate leaves).

Uraria lagopoides DC. Mt. Warirata; Yule Island.

Phylacium bracteosum Benn. Javararie; Sogeri; Mafulu (a very common climber); [Boku, *Mrs. H. P. Schlencker.*]

Dalbergia densa Benth. Bail. Rep. Visit B.N.G., 28. Yule Island. A form with large leaflets, the leaflets up to 2¾ in. long and 1½ in. broad.

D. monosperma Dalz. Port Moresby. A common climber on the coast over mangrove trees, etc.

Derris uliginosa Benth. Yule Island. Known in Papua under the name of "Dynamite Plant" from its use by the natives as a fish-poison.

Inocarpus edulis R. & G. Forst. Bail. Ann. Rep. B.N.G. 1900-01, 142; Queens. Agric. Journ., xxii, 147. Yule Island.

Abrus precatorius Linn. F. Muell. Pap. Pl., i (iv), 62. Port Moresby.

Clitoria ternatea Linn. Port Moresby.

This pretty little climber is seen everywhere about the town, over the fences of the native gardens, etc. Flowers varying from almost white to very deep blue.

Glycine tomentosa Benth. Yule Island.

Erythrina indica Lam. Coral tree. F. Muell. Pap. Pl., ii (vi), 8; Bail. Rep. Visit B.N.G., 27, 28. Port Moresby; Yule Island.

Mucuna gigantea DC. Yule Island.

M. Kraetkei Warb. Schum. & Laut. Nachtr. Flora der Deutsch. Schutzg, Sudsee 278. Sogeri.

Fairly common; a most magnificent climber with brilliant scarlet flowers. This and *M. Bennettii* F. Muell. both go under the name of "D'Albertis' Creeper."

M. Stanleyi sp. nov.

Ramulis, ferrugineo-hirsutis; foliis longe petiolatis, foliolis amplis breviter petiolulatis subtus dense ferrugineo-pubescentibus suborbicularibus apice acuminatis lateralibus maxime obliquis, stipellis filiformibus, pannicula ferrugineo-hirsuta; calyce fere ad medium 4-lobo (bilabiato) tubo utrinque hirsuto, legumine 3-5 spermo, valvis lamellis obliquis imbricatis munitis.

A large forest climber, branchlets and petioles hirsute with long rust-coloured hairs. Leaflets nearly orbicular or lateral ones very oblique, apex acuminate, very thinly pubescent above, densely ferruginous-pubescent beneath, lateral ones 4-5½ in. (10-14 cm.) long, 5-5½ in. (12·5-14 cm.) broad, all on petiolules of about 3 lines (6 mm.); stipules absent (?), stipellæ filiform about 5 lines (1·1 cm.) long; length of petiole below the lateral leaflets about 3 in. (7·5 cm.) long, length of rhachis between the lateral leaflets and terminal one about ¾ in. (2 cm.). Panicle branches densely rufous-pubescent with long spreading hairs. Bracts ovate-lanceolate, acuminate, ¾-1 in. (2-3.2 cm.) long, clothed with long brown hairs. Calyx about 1 in. (2-5 cm.) long, 4-lobed (2-lipped), upper lip about 3 lines (6 mm.) long, lateral lobes of the lower lip 3 lines (6 mm.) long, lowest lobe about 6 lines (1·3 cm.) long, hirsute both inside and out with ferruginous hairs. Corolla whitish (rather imperfect in the dried specimens for dissection); standard reflexed, wings rather longer, keel still longer (about 2 in. (5 cm.) long) with a short indurated beak. Pod about 5½ in. (14 cm.) long, covered with close oblique pleats 3-5-seeded; seeds about 1 in. (2·5 cm.) across.

Mafulu.

Named after Mr. Evan R. Stanley, Government Geologist of Papua, who accompanied me on my two longer trips in the Territory. This new species comes very close to *M. Albertisii* F. Muell., but I think is sufficiently different to stand as a distinct species. The chief differences are as follow:—

M. Albertisii: Branchlets densely but rather closely ferruginous-pubescent; leaflets 3½-5 in (9-13 cm.) long; panicle branches velvety pubescent; calyx velvety pubescent with a few bristly hairs at the base of the tube ½-⅔ in. (1·3-1·7 cm.) long.

M. Stanleyi : Branchlets and panicle branches hirsute with long spreading hairs ; leaflets 4-6½ in. (10-16·5 cm.) long ; calyx hirsute with long brown hairs, 1 in. (2·5 cm.) long.

Canavalia obtusifolia DC. F. Muell. Pap. Pl., i (iii), 42 ; Bail. Rep. Visit B.N.G., 27, 28. Port Moresby.

Atylosia scarabæoides Benth. Sapphire Creek.

A. grandifolia F. v. M. Astrolabe Range. The Papuan specimens have a more robust appearance and are more densely pubescent than the Australian specimens but otherwise agree with them.

Rhynchosia Cunninghamii Benth. Yule Island.

Flemingia strobilifera R. Br. Bail. Queens. Agric. Journ., xxii, 147 ; xxiii, 220. Port Moresby ; Astrolabe Range.

F. lineata Roxb., var. **papuana** n. var. A stronger growing plant than the normal form ; branchlets densely ferruginous-pubescent ; leaflets up to 4¼ in. (10·7 cm.) long and 1¾ in. (4·5 cm.) broad ; panicles correspondingly large.

Sapphire Creek.

Dolichos Lablab Linn. F. Muell. Pap. Pl., i (v), 88. Astrolabe Range.

FAMILY GERANIACEÆ.

Biophytum Apodiscias Turcz. Deva Deva (Mafulu District).

FAMILY RUTACEÆ.

Evodia mollis Warb. Bella Vista (Mafulu District, 4,800 ft.).

[**E. alata** F. Muell. F. Muell. Pap. Pl., ii (vii), 26. Boku (Papua), *Mrs. H. P. Schlencker* ; near Finschhafen (late Kaiser Wilhelm's Land), *Dr. Carl Weinland* (No. 178) ; received from Botanic Gardens, Berlin, as **E. mollis** Warb.

Mrs. Schlencker's specimen represents a very robust form with leaflets nearly 1 ft. (31 cm.) long and 7 in. (18 cm.) broad and with the main veins very prominent beneath, and when flowers are available it may possibly prove a new variety or species.

E. mollis and *E. alata* are evidently closely allied, but can be distinguished by the following characters :—

E. mollis : Under surface of lamina of leaf closely covered by a dense velvety stellate tomentum.

E. alata : Veins and veinlets on the under surface covered (often thinly) by a stellate tomentum.]

E. lamprocarpa K. Sch. Javararie.

Lunasia quercifolia (Warb.) Laut. & Sch. Flora Deutschen Schutz. Sudsee, 376. *Androcephalium quercifolium* Warb. Pl. Hellwig. 197 (ex Engl. Jahrb. xviii 1893) ; *L. amara* F. Muell. Pap. Pl. (ii), viii, 42 (*non* Blanco). Sapphire Creek and Yule Island. Some of my Sapphire Creek specimens are in fruit. Cocci 4, often only 1 ripening, somewhat cuneate, 5 lines (1·1 cm.) long and about 4 lines (8 mm.) long at the top, valves tomentose, more or less prominently transversely wrinkled.

Flindersia papuana F. Muell., Pap. Pl., i (v), 84 ; C. T. White, Proc. Linn. Soc. N.S.W., 46, 329. Between Okaka and Mafulu.

Glycosmis pentaphylla Corr. F. Muell. Pap. Pl., i (iv), 54. Port Moresby ; Bioto (Mekeo District).

Micromelium pubescens Bl. F. Muell. Pap. Pl., i (iv), 54 ; Bail. Rep. Visit B.N.G., 27 ; Queens. Agric., xxiv, 20. Sogeri District ; Yule Island.

Murraya exotica Linn. Bioto (Mekeo District).

Family SIMARUBEÆ.

Harrisonia Brownii A. Juss. Port Moresby.

Family BURSERACEÆ.

Canarium australasicum F. Muell. Bail. Rep. Visit B.N.G., 27. Port Moresby.

Family MELIACEÆ.

Turræa pubescens Hellen. F. Muell. Pap. Pl., i (iv), 53. Port Moresby.

Melia Azedarach Linn. F. Muell. Pap. Pl., ii (vi), 5. White Cedar. Laloki River.

Chisocheton Biroi Harms. Branchlets myrmecophilous ; flowers white ; fruit red. Deva Deva.

It is with some hesitation I refer my specimens to the above and when better known it may prove a distinct species. It differs from typical *C. Biroi* in the leaves attaining over 60 cm. (2 ft.) in length and the individual leaflets over 20 cm. (8 in.) in length by 70 cm. (4 in.) in breadth. The branchlets also are myrmecophilous—a fact not mentioned by Harms. These, however, are all points that he might not have been able to see with the material at his disposal.

Aglaia elæagnoidea Benth. F. Muell. Pap Pl., i (i), 6. Yule Island.

A. sapindina (F.v.M.) Harms. Mekeo District.

Carapa moluccensis Lam. Bail Queens. Agric. Journ., ix, 410, and xxiv, 20. Port Moresby.

Family EUPHORBIACEÆ.

Flueggea microcarpa Blume. Port Moresby.

The plant recorded as *Flueggea microcarpa* by Bailey in Queens. Agric. Journ. xxiii, 219, is a very different plant, probably an undescribed species of *Glochidion*.

Phyllanthus urinaria L. Mt. Warirata (Astrolabe Range).

Glochidion magnificum K. Sch. Mafulu.

My specimens are in fruit only, but I have little doubt of the determination. The capsules are densely pubescent, and about 4 lines (9 mm.) in diameter.

G. Ferdinandi Muell. Arg., var. **supra-axillaris** Benth. Mafulu.

Breynia cernua (Poir.) Muell. Arg. F. Muell. Pap. Pl., ii (6), 5. Mafulu.

Bridelia tomentosa Bl. Sapphire Creek.

A form with rather small leaves; it agrees fairly well with specimens from Somerset and Torres Strait, North Queensland (referred to by Bailey, Queens. Flora v, 141) and Rept. Aus. Assoc. Adv. Sc., vii, 442.

B. subnuda Schumm. & Laut. Bisiatabu.

In the absence of material for comparison, it is with some hesitation I make the above determination.

Claoxylon Hillii Benth. Sogeri.

Mallotus paniculatus Muell. Arg. Mafulu.

Macaranga angustifolia Laut. & K. Sch. Deva Deva.

M. punctata K. Sch. Bisiatabu (Astrolabe Range); also a doubtful specimen from the Mekeo District.

Acalypha insulana Muell. Arg. Astrolabe Range and Sogeri.

A. Hellwigii Warb., var. **mollis** Warb. Deva Deva and Mafulu.

For the determination of the above species of *Mallotus*, *Macaranga*, and *Acalypha* I am indebted to the Director, Royal Botanic Gardens, Kew, England.

* **Jatropha gossypiæfolia** Linn. Port Moresby. This South American plant is a great pest in parts of North Queensland.

Codiæum variegatum Bl., var. **moluccanum** Muell. Arg. (*C. chrysostictum* Rumph.). F. Muell. Pap. Pl., i (iv), 60. Yule Island.

Homalanthus populifolius Grah. Astrolabe Range and Sogeri.

Euphorbia Drummondii Boiss. Port Moresby. A small, red, decumbent weed; the same form is common in coastal Queensland, and I have also received specimens from Fiji.

E. pilulifera Linn. Bail. Rep. Visit B.N.G., 27; Queens. Agric. Journ., xxiii, 220. Port Moresby (a common weed).

E. serrulata Reinw. Sapphire Creek and Astrolabe Range. A form with very narrow leaves with the edges almost entire.

* **E. (Poinsettia) heterophylla** Linn. Yule Island. A common weed in plantations, etc.

FAMILY ANACARDIACEÆ.

Mangifera minor Bl. Port Moresby. A large handsome tree.

Buchanania papuana sp. nov.

Ramulis novellis dense pubescentibus, deinde glabris; foliis glaberrimis, coreaceis lanceolatis oblanceolatis vel obovatis; a medio in petiolum cuneatim angustatis, nervis lateralibus circa. 10-15 patentibus; paniculis pilosis deinde glabris; calycis lobos triangularibus, petalis oblongis; gynœcio strigoso; drupis compressis; breviter pilosis, apiculo excentrico.

A medium-sized tree with a spreading top. Young branchlets pubescent, older ones glabrous, lenticellate, stout. Leaves petiolate, petiole about 1 in. (2·5 cm.) long; lamina 4½-7½ in. (11·5-19 cm.) long, 2-3 in. (5-7·5 cm.) broad; lanceolate, oblanceolate or sometimes obovoid, glabrous, main lateral nerves prominent on both faces. Panicle about as long as the leaves, widely spreading, rhachis and branchlets bearing a few scattered hairs but soon quite glabrous. Calyx about ½ line (1 mm.) long, glabrous or almost so, lobes triangular. Petals about 1 line (2 mm.) long, oblong. Anthers sagittate. Gynœcium strigose-pubescent. Drupe with a few scattered hairs, 3-4 lines (6-9 mm.) in diameter, compressed-globose; apex almost terminal.

Laloki River.

This new species is very closely allied to the common Australian *B. Muelleri*, from which it is distinguished chiefly by its larger more coriaceous and more strongly veined leaves, its wider spreading panicle, and more pointed calyx lobes. In systematic position it comes between *B. florida* and *B. Muelleri*.

B. florida: Drupe glabrous, apex excentric. Leaves 10-15 cm. long, 4-5 cm. broad.

B. Muelleri: Drupe clothed with a few scattered hairs. Leaves ca. 10 cm. long, 5-6 cm. broad.

B. papuana: Drupe clothed with a few scattered hairs. Leaves 11-19 cm. long, 5-7·5 cm. broad.

Semecarpus australiensis Engler. Port Moresby.

S. undulata sp. nov.

Arbor humilis, ramulis crassis; foliis breviter petiolatis obovato-lanceolatis breviter acuminatis, basim versus a triente superiore longe cuneatim angustatis, undulatis, coriaceis, supra glabris nitidulis, subtus pallidis reticulatis, costa et nervis lateralibus tenuiter pilosis, venis tenuiter pilosis et glanduloso-punctatis; paniculis axillaribus vel lateralibus, elongatis, ramulis tenuis glabrescentibus; floribus masculis glomeratis, calycis 5-lobis, strigoso-pubescentibus, petalis strigoso-pubescentibus, staminibus glabris petalis æquantibus; drupis ovoideis compressis pubescentibus, apiculo centrico hypocarpio obconico, pubescentibus.

A small tree, usually with a single stem, the leaves arranged around it in dense false whorls. Leaves subsessile, or very shortly petiolate on a petiole of 2-5 lines (·4-1·1 cm.): lamina 7-14 cm. (17·5-36 cm.) long; obovate-lanceolate. Apex shortly and rather bluntly acuminate, lower part gradually tapering to the base, under surface pale coloured—but not white—with a very dense close tomentum between the veinlets, the veins and veinlets prominently raised, clothed with a few scattered hairs and glandlike markings. Panicles lateral or axillary, branched at the base into several elongate slender branches, the branches glabrescent, the main rhachis in the specimens to hand attaining 2 ft. 9 in. (82·5 cm.) long. Male flowers whitish, in dense clusters along the branches of the panicle; calyx strigose-pubescent, 5-lobed, scarcely ½ line (1 mm.) long; petals strigose-pubescent on the outer surface; scarcely 1 line (1½ mm.) long, stamens about the same length as the petals, filaments glabrous, slightly flattened at the base. Female flowers unknown. Drupe green (perhaps not seen quite ripe), about 1¼ in. (3·2 cm.) long and ¾ in. (2 cm.) broad in the dried specimens, compressed-ovoid, apex almost centric; pericarp pubescent with a close ferruginous pubescence, easily rubbed off in the dried fruit ; receptacle densely ferruginous-pubescent with a close pubescence about 5 lines (1·1 cm.) in diameter.

Astrolabe Range (type) ; Port Moresby.

The Astrolabe Range specimens bear both flowers and fruits. The Port Moresby specimens have leaves rather longer and narrower and more markedly sessile than the Astrolabe ones ; the panicle is also somewhat differently branched. But I have little hesitation in referring it to the same species.

Semecarpus sp. Leaves shortly petiolate, petiole about 1½ in. (4 cm.) long ; lamina up to 15 in. (37·5 cm.) long and 5½ in. (13·7 cm.) wide, glaucous beneath. Drupe (not seen quite ripe) obliquely obcordate, about 1 in. (2·5 cm.) across ; compressed, thinly pubescent ; receptacle obconical, about ¼ in. (·6 mm.) long, pubescent.

Javararie.

Probably represents a new species but the material hardly allows me to name it. In addition to the above I collected a species in flower only at Yule Island ; and in the Queensland Herbarium there is another apparently undescribed species from Boku, collected by Mrs. H. P. Schlencker ; the material consists of one leaf and a couple of ovoid, fulvous-pubescent fruits.

Family SAPINDACEÆ.

Cardiospermum Halicacabum Linn. F. Muell. Pap. Pl., i (iv), 53 ; Bail. Rep. Visit B.N.G., 27. Port Moresby.

Alectryon ferrugineum (Bl.) Radlk. *Nephelium ferrugineum* Bl. ; F. Muell. Pap. Pl., i (ii), 21. Port Moresby.

Mischocarpus lachnocarpus (F. Muell.) Radlk. *Ratonia lachnocarpa* F. Muell. Mekeo District.

Jagera serrata (Roxb.) Radlk. Sogeri.

Dodonæa viscosa Linn. F. Muell. Pap. Pl., i (ii), 21. Mafulu, 4,000 ft.

Family BALSAMINACEÆ.

Impatiens sp. Mafulu—very abundant along mountain roadside (3,000-4,000 ft.). My specimens are rather too imperfect to determine specifically.

Family RHAMNACEÆ.

Colubrina asiatica Rich. F. Muell. Pap. Pl., i (i), 7. Port Moresby.

Gouania microcarpa P. DC. Astrolabe Range.

Family VITACEÆ.

Cissus trifolia (Linn.) K. Sch. *Vitis trifolia* Linn. ; F. Muell. Pap. Pl., i (v), 86. Port Moresby.

C. pedata Lam. *Vitis pedata* Wall. Astrolabe Range.

[**C. discolor** Lam. *Vitis cordata* Bail. Queens. Agric. Journ., iii, 154, 1898 (*non* Wall.) Mambare River, *F. M. Bailey.*

I have little hesitation in referring Bailey's plant to *C. discolor.* The leaf in the dried specimens shows no white marking, but these are not always present. Bailey l.c. describes the inflorescence as red, a character of some forms of *C. discolor.*]

Leea sambucina Willd. Bail. Rep. Visit B.N.G., 27, 28. Port Moresby ; Astrolabe Range. It is recorded for Darnley Island by Mueller in his "Papuan Plants," i (iii), 36, but this is in Queensland territory.

L. æquata Linn. Sogeri.

Family TILIACEÆ.

Grewia orientalis Linn. F. Muell. Pap. Pl., ii (viii), 41. Port Moresby ; Yule Island.

G. latifolia F. Muell. Port Moresby.

Triumfetta rhomboidea Jacq. F. Muell. Pap. Pl., ii (ix), 56 ; Bail. Rep. Visit B.N.G., 27. Port Moresby ; Yule Island.

T. pilosa Roth. F. Muell. Pap. Pl., ii (ix), 56. Javararie ; Mafulu.

T. semitriloba Linn. Bail. Queens. Agric. Journ., xxiii, 220.

Althoffia pleiostigma (F. Muell.) Warb. (*Grewia pleiostigma* F. Muell.) ; F. Muell. Pap. Pl., i (iv), 58. Sapphire Creek. A very pretty tree with lavender-coloured flowers.

A. tetrapyxis K. Sch. Astrolabe Range ; Mafulu.

I very much doubt if these two species of *Althoffia* can be kept distinct. My specimens of the former are in flower, of the latter in fruit. We also have fruiting specimens of *A. tetrapyxis* from Mrs. Schlencker, collected at Boku, with the remark, "Bears small white flowers" ; so I have refrained from uniting them until more definite information is to hand.

Family MALVACEÆ.

Abutilon auritum G. Don. F. Muell. Pap. Pl., i (iv), 55. Port Moresby. Very common in the native gardens.

A. asiaticum G. Don. Port Moresby.

Sida spinosa Linn. F. Muell. Pap. Pl., i (iv), 55. Port Moresby.

S. acuta Burm. Yule Island.

S. rhombifolia Linn. *S. retusa* L. Port Moresby.

S. cordifolia Linn. Flannel weed. Port Moresby.

***Malvastrum tricuspidatum** A Gray. Port Moresby.

Urena lobata Linn. F. Muell. Pap. Pl., i (iv), 55; Becc. in D'Albertis' "New Guinea," ii, 396; Hemsl. Kew Bulletin 1899, 97. Sapphire Creek; Astrolabe; Sogeri; Mafulu.

The species of *Sida, Malvastrum, and Urena* here recorded are common Asiatic, Papuan, and Tropical Australian weeds.

Hibiscus ficulneus Linn. F. Muell. Pap. Pl., i (iv), 56. Port Moresby. As in parts of Northern Queensland during the winter months, the upright dead stems with their racemes of old capsules can be seen everywhere in the grass land.

H. D'Albertisii F. Muell. Pap. Pl., i (iv) 55 and ii (viii), 41. Very common between Kubunah and Fofofofo (Mekeo District).

H. vitifolius Linn. F. Muell. Pap. Pl., i (iv), 56. Bioto (Mekeo District).

H. tiliaceus Linn. F. Muell. Pap. Pl., i (iv), 56; Bail. Rep. Visit B.N.G., 27. Port Moresby.

FAMILY BOMBACACEÆ.

Bombax malabaricum DC.; Bail. Rep. Visit B.N.G., 27. Silk Cotton tree. Port Moresby; Yule Island. This tree, bearing its large red flowers, is a conspicuous feature in the landscape.

FAMILY STERCULIACEÆ.

Melochia pyramidata Linn. F. Muell. Pap. Pl., i (iii), 36. Port Moresby.

M. vitiensis A. Gray. F. Muell. Pap. Pl., i (iv), 55. Sapphire Creek; Astrolabe Range; Sogeri.

[**M. indica** (Houtt) A Gray. *Commersonia* sp. F. M. Bail. in Ann. Rept. B.N.G. 1900-01, p. 142. East Coast, British New Guinea, *Sir G. R. Le Hunte.*]

Waltheria americana Linn. Port Moresby. A common weed.

Abroma augusta Linn. f. F. Muell. Pap. Pl., i (iii), 36; *A. fastuosa* Bail. Queens. Agric. Journ., xxiv, 20 (*non* R. Br.). Port Moresby.

Can be distinguished from the common Australian *A. fastuosa* R. Br. by its entirely unarmed branches and branchlets.

Sterculia Edelfeldtii F. Muell. Vic. Nat., iii, 47; Pap. Pl., ii (ix), 55. Yule Island; Kubunah (Mekeo District).

The Yule Island specimens are in flower, the Kubunah specimens in fruit, and seem to represent two forms both of which I doubtfully refer to *S. Edelfeldtii*, which is evidently either a very variable plant or else more than one species was included by Mueller l.c. under it.

Family DILLENIACEÆ.

Wormia sp. Dilava. My specimens consist of a couple of leaves and a few fallen flowers only, and do not allow me to give a specific name. It is a large tree producing a useful timber known at Dilava as "Manava." The leaves are borne on a petiole of about 2½ in. (6·3 cm.), lamina suborbicular about 7 in. (17·5 cm.) long and 6½ in. (16·5 cm.) broad, strongly veined on the under surface.

Family BIXACEÆ.

Cochlospermum Gillivræi Benth. F. Muell. Pap. Pl., i (iv), 54; Bail. Queens. Agric. Journ., xxiv, 20. Port Moresby. A small tree very common on rocky foreshores round the harbour.

Bixa Orellana Linn. Bail. Queens. Agric. Journ., vii, 348, and xxiii, 221. Sogeri; Mafulu.

Family PASSIFLORACEÆ.

Passiflora fœtida L. Naturalised almost everywhere near settlements.

Family SONNERATIACEÆ.

Sonneratia alba Sm. Bail. Ann. Rep. B.N.G. 1900-01, p. 143. Port Moresby.

S. lanceolata Bl. A riverside or estuarine tree, sending up numerous slender pneumatophores; branchlets slender, glabrous. Leaves glabrous, lanceolate or ovate-lanceolate, oblique and tapering at the base into a short petiole; petiole about 3 lines (6 mm.) long; lamina 3-4 in. (7·5-10 cm.) long and ¾-1 in. (2-2·5 cm.) broad. Flowers apetalous. Calyx 6-lobed, stamens white, numerous. Fruit about 1 in. (2·5 cm.) across.

Ethel River (very abundant).

I have little doubt in referring my specimens to *S. lanceolata* Bl. (Mus. Lugd. Bot., i, 337). He describes the flower as 6-petaled: the only flower available to me is apetalous, but this is not sufficient ground for separation. The only description of the plant I have at my command is Blume's original one. In the field at a cursory glance the tree might easily be mistaken for the widely distributed *Avicennia officinalis*; it is very different in appearance from the much commoner congener *S. alba.*

Family LECYTHIDACEÆ.

Barringtonia calyptrata O. Ktze. C. T. White, Proc. Linn. Soc. N.S.W., xliv, 823. Yule Island.

Family RHIZOPHORACEÆ.

Rhizophora mucronata Lam. Red Mangrove. Port Moresby. The principal tanning mangrove.

Ceriops Candolleana Arn. Small Mangrove. Port Moresby.

Bruguiera gymnorhiza Lam. (*B. Rheedii* Bl., F. Muell. Pap. Pl., viii, 44.) Port Moresby. Hooker (Flora British India, ii, p. 437) unites *B. Rheedii* with *B. gymnorhiza*.

B. eriopetala W. & A. Port Moresby.

Family COMBRETACEÆ.

Terminalia Catappa Linn. Fiji Almond. Bail. Rep. Visit B.N.G., 27: Foxworthy Ann. Rep. Papua 1909-10, p. 114. Yule Island.

Planted in the streets of Port Moresby as a shade tree.

T. Okari sp. nov.

Arbor magnis; ramulis novellis ferruginoso-pubescentibus; foliis breviter petiolatis obovatis (20-27·5 cm. longis, 10-12·5 cm. latis), supra glabrescentibus subtus prominente nervosis, nervis dense pubescentibus; floribus ignotis; drupis obovoideis, magnis (ca. 17·5 cm. longis et 7·5 cm. latis); pericarpio fibroso, endocarpio osseo, semine ellipsoideo (ca. 7·5 cm. longo et 2 cm. lato).

A tall tree, young shoots densely ferruginous-pubescent. Leaves obovate, tapering at the base into a short petiole, 8-11 in. (20-27·5 cm.) long, 4-5 in. (10-12·5 cm.) wide, glabrous above with the exception of a few scattered hairs on the midrib and main lateral nerves; under surface prominently veined, the midrib and main lateral nerves raised and densely ferruginous-pubescent; petiole pubescent about 1 in. (2·5 cm.). Flowers not seen. Fruit deep reddish purple, obovoid, about 7 in. (17·5 cm.) long and 3 in. (7·5 cm.) broad; pericarp fibrous with interlacing fibres, endocarp ossified, very rugose; seed narrowly ellipsoid, about 3 in. (7·5 cm.) long and ¾ in. (2 cm.) broad; testa thin, dark brown.

Bisiatabu (type); Sogeri (common); [Boku, *Mrs. H. P. Schlencker*].

A large tree; the seed, known in Papua as the "Okari nut," is a favourite with natives and Europeans alike; by the latter the nuts are often eaten "devilled" in the same way as almonds. It is probably one of the finest of tropical nuts.

Combretum Goldieanum F. Muell. Pap. Pl., i (iv), 66. Port Moresby; Yule Island.

This rambling scandent shrub is very common about Port Moresby and with its brilliant red flowers is quite a conspicuous feature in the vegetation. The fruits are "shortly stipitate, nearly 1 in. (2·5 cm.) long, and prominently winged with 5 dry more or less membranous wings."

Gyrocarpus americanus Jacq. F. Muell. Pap. Pl., ii (vi), 7; Vic. Nat. Feb. 1885. Port Moresby.

FAMILY MYRTACEÆ.

Rhodamnia cinerea Jack. Bisiatabu.

The specimens are in leaf only but I have little hesitation in referring them to the above species. I cannot follow King ("Materials for a Flora of the Malayan Peninsula") and others in uniting so many species under *R. trinervia*.

Decaspermum neurophyllum Laut. & K. Sch. Deva Deva. A large shrub or small tree; flower-buds pink; in the open flower the petals white or flesh-coloured and stamens pink.

Melaleuca sp. (aff. *M. Leucadendron* Linn.). Astrolabe Range.

This tree is common on the range. It has a papery bark and white flowers. For the present I do not care to give it a specific name. I cannot class all the various forms allied to *M. leucadendron* L. as varieties, as done by King ("Materials for a Flora of the Malayan Peninsula"), Cheel (in Ewart & Davies's "Flora of the Northern Territory"), and others.

* **Eucalyptus tereticornis** Sm. Blue Gum of Queensland, Forest Red Gum of N. S. Wales. F. Muell. Pap. Pl., ii (ix), 59;

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* For the identification of the Eucalypts I am indebted to Mr. J. H. Maiden, I.S.O., F.R.S., Govt. Botanist, Sydney.

Ann. Rep. B.N.G. 1889-90, 106; Maid. Proc. Linn. Soc. N.S.W. xxvi, 540; Forest Flora N.S.W. ii, 3; Critical Rev. Gen. Euc. iv, 11. Astrolabe Range (common).

E. alba Reinw. Poplar Box, White Box of North Queensland. Maiden, Critical Revision Gen. Euc., iii, 97; *E. platyphylla* F. Muell.; Bail. Rep. Visit B.N.G., 27. Port Moresby (the common broad-leaved form); Astrolabe Range (leaves much narrower, even to narrow lanceolate). This tree is readily distinguished in the field by its clean white trunk and branches.

E. clavigera A. Cunn. Port Moresby; Astrolabe Range. This Eucalypt is fairly common, and easily distinguished by the blackish tessellated bark at the butt, extending for about 5 to 10 ft. up the trunk.

E. papuana F. Muell. Pap. Pl., i (i), 8; Bail. Rep. Visit B.N.G., 27; Maid. Crit. Rev. Gen. Euc., iv. 196. Port Moresby (very common).

Family MELASTOMACEÆ.

Otanthera bracteata Korth. Mafulu.

O. setulosa K. Sch. Nacht. Fl. Deutsch. Schutzg. Sudsee, 327. Sogeri. The fruits are red and about 8 lines (1·7 cm.) diameter.

Melastoma polyanthum Bl. Astrolabe Range, and range between Sogeri and Javararie.

Osbeckia chinensis Linn. Mt. Warirata (Astrolabe Range).

Medinilla Forbesii E. G. Baker in Trans. Linn. Soc., n. ser., Bot., ix, 55. Dilava.

Family ŒNOTHERACEÆ.

Jussiæa suffruticosa Linn. F. Muell. Pap. Pl., i (iv), 60; Bail. Rep. Visit B.N.G., 28. Port Moresby.

Family HALORRHAGIDACEÆ.

Gunnera macrophylla Bl., var. **papuana** Warb. Deva Deva.

Family UMBELLIFERÆ.

Hydrocotyle hirta R. Br. Javararie. A common weed on damp plantation tracks.

Family MYRSINACEÆ.

Ægiceras majus Gærtn. ; Bail. Ann. Rep. B.N.G. 1900-01, p. 143 ; *A. fragrans* Koenig, F. Muell. Pap. Pl., i (iv), 70. Port Moresby. A common tree in the mangrove swamps.

Family PLUMBAGINACEÆ.

Plumbago zeylanica Linn. F. Muell. Pap. Pl., i (iv), 58. Port Moresby.

Family SAPOTACEÆ.

Mimusops parvifolia R. Br. Port Moresby ; Yule Island.

Family EBENACEÆ.

Diospyros maritima Bl. Yule Island and mainland opposite (Mekeo District).

Family OLEACEÆ.

Jasminum didymum Forst. F. Muell. Pap. Pl., i (i), 11. Port Moresby.

Family LOGANIACEÆ.

Fagræa obovata Wall., var. **papuana** Bail. Queens. Agric. Journ. iii, 157 (1898). Sapphire Creek and Astrolabe Range.

Family APOCYNACEÆ.

Alstonia scholaris R. Br. F. Muell. Pap. Pl., i (iv), 70 ; Hemsley Kew Bull. 1899, 106 ; Foxworthy in Ann. Rep. Papua 1909-10, p. 114. Port Moresby. A very common tree. In North Queensland known as " Milky Pine."

A. longissima F. Muell. Pap. Pl., i (v), 91. Port Moresby.

Family ASCLEPIADACEÆ.

Dischidia Rafflesiana Wall. Bisiatabu (Astrolabe Range). Epiphytic on trees.

[**D. ovata** Benth. Kwato Island, *E. Cowley*.]

Family CONVOLVULACEÆ.

Ipomæa grandiflora Lam. Port Moresby. A climber with large white flowers.

I. Turpethum R. Br. F. Muell. Pap. Pl., ii (viii), 49. Yule Island.

Lepistemon urceolatus F. v. M. Mafulu.

Convolvulus multivalvis R. Br. Port Moresby.

Merremia bufalina (Lour.) Merr. & Rolfe. Port Moresby.

Family BORAGINACÆ.

Cordia subcordata Lam. F. Muell. Pap. Pl., i (iii), 44; Bail. Rep. Visit B.N.G., 27, 28; Queens. Agric. Journ., ix. 411 (1901). Port Moresby. The Rev. H. P. Schlencker gave me the native name about Port Moresby for this plant as "Turi-turi."

Tournefortia mollis F. Muell. F. Muell. Pap. Pl., i (iv), 71. Port Moresby. Common on the hills.

T. sarmentosa Linn. f. F. Muell. Pap. Pl., i (i), 11. Mekeo District.

Family VERBENACEÆ.

Geunsia farinosa Blume. Mafulu.

Callicarpa longifolia Lam. Hemsley Kew Bull. 1899, 108.

C. caudata Maxim. Mafulu. I have not got the original description of this species to refer to but have named it by comparison with Philippine material of typical *C. caudata* received from Dr. E. D. Merrill, Bureau of Science, Manila. P.I.

[**C. pedunculata** R. Br. Boku, *Mrs. H. P. Schlencker*. Papuan name "Manutagi."]

Premna obtusifolia R. Br. Bail. Queens. Agric. Journ., xxiii, p. 220. Port Moresby.

P. nitida K. Sch. Astrolabe Range.

Vitex trifolia Linn. F. Muell. Pap. Pl., i (i), 11; Bail. Rep. Visit B.N.G., 27. Port Moresby; [Samarai, *W. E. Armit*].

Clerodendron inerme R. Br. F. Muell. Pap. Pl., i (i), 11. Port Moresby; [Normanby Island, *Sir. G. R. Le Hunte*]; [Port Moresby, *E. Cowley*, who quotes the native name as "Quamo-quamo."]

C. floribundum R. Br. F. Muell. Pap. Pl., i (v), 90; Bail. Queens. Agric. Journ., xxii, 148. Port Moresby.

C. Tracyanum F. Muell. F. Muell. Pap. Pl., i (v), 91; Bail. Ann. Rep. B.N.G. 1900-01, p. 143. Mekeo District [Samarai, *W. E. Armit*].

Avicennia officinalis Linn. Bail. Rep. Visit B.N.G., 28, and in Ann. Rep. B.N.G. 1900-01, 143. Port Moresby.

Family LABIATÆ.

Anisomeles salvifolia R. Br. Port Moresby. A very robust form common on the hills about the town. Mueller (Pap. Pl., i (iii), 45) records this from Darnley Island, which is, however, in Queensland territory.

***Hyptis sauveolens** Poit. C. T. White, Queens. Agric. Journ., xii, n.s. 141, pl. 16 (1919). Port Moresby. A very common weed.

Coleus scutellarioides Benth. F. Muell. Pap. Pl., ii (vi), 15. Sogeri.

Ocimum basilicum Linn. *O. sanctum* Bail. Ann. Rep. B.N.G. 1900-01, 143 (*non* Linn.). Port Moresby ; [Cape Nelson, *G. R. Le Hunte*]. A strongly scented herb ; a common weed in native gardens, etc. ; worn by men in armlets, especially at native dances.

O. sanctum Linn. F. Muell. Pap. Pl., i (v), 90 ; Bail. Rep. Visit B.N.G., 27, 28 ; (*Moschosma polystachyum* Bail. in Queens. Agric. Journ., xxiii, 148, and xxiv, 120 *non.* Benth). Yule Island ; [Port Moresby, *E. Cowley* ; Boku, *Mrs. H. P. Schlencker*].

Orthosiphon stamineus Benth. F. Muell. Pap. Pl., i (iii), 45 ; Bail. Rep. Visit B.N.G., 27, 28. Sogeri.

Family SOLANACEÆ.

Solanum viride R. Br. F. Muell. Pap. Pl., ii (viii), 49. Sogeri.

S. verbascifolium Ait. F. Muell. Pap. Pl., i (iii), 44 ; Bail. Queens. Agric. Journ., xxiii, 220. Port Moresby.

[**S. torvum** Sw. Hemsley Kew Bull. 1899, 107 ; *S. stelligerum* Bail. in Ann. Rep. B.N.G. 1900-01, 143 (*non.* Sm.). Trobriand Islands, *G. R. Le Hunte.*

These specimens, referred by Bailey l.c. to *S. stelligerum,* represent to my mind typical *S. torvum.*]

S. torvum Sw. Sogeri. A common *Solanum* in secondary growth, height about 10 ft., flowers white, berries about 4 lines (9 mm.) in diameter, but only seen green.

This possibly represents a new species ; it approximates closely a densely tomentose form growing in the Philippines. I wrote Mr. Merrill, Director, Bureau of Science, Manila, P.I., about these Papuan specimens, and he replied : " I note your query in reference to *S. torvum.* The specimens certainly very strongly resemble Philippine material which I have referred to this species for want of a better disposition of such material. We have typical *S. torvum* in the Philippines growing in waste places and about towns. It is erect, branched, suffrutescent, spiny, and has white or nearly white flowers. The Philippine form which approximates your New Guinea specimen has purple or violet flowers, and I am by no means certain whether it can be referred to *S. torvum*."

S. repandum Forst. F. Muell. Pap. Pl., i (v), 91. Sogeri.

S. discolor R. Br. Bioto (Mekeo District).

Family SCROPHULARIACEÆ.

Limnophila gratioloides R. Br. F. Muell. Pap. Pl., ii (ix), 63 ; Ann. Rep. B.N.G. 1889-90, 107.

Vandellia crustacea Benth. F. Muell. Pap. Pl., i (v), 99 ; Bail. Queens. Agric. Journ., xxii, 148 : Hemsley in Kew Bull. 1899, 107. Sogeri.

Bonnaya veronicæfolia Spreng. Laloki River ; Mekeo District.

Buchnera urticifolia R. Br. Mt. Warirata.

Family BIGNONIACEÆ.

Diplanthera tetraphylla R. Br. Astrolabe Range and Sogeri. A very common tree.

Family GESNERIACEÆ.

Bœa lanuginosa Sch. & Laut. Bisiatabu (on rocks). My specimens are rather fragmentary but belong, I believe, to the above.

Rhyncoglossum obliquum Bl. Deva Deva. A pretty blue-flowered herb common along forest tracks in the Mafulu District.

Family ACANTHACEÆ.

An account of the Acanthaceæ collected will be found in a paper " Acanthaceæ Papuanæ" by Mr. Spencer Le M. Moore, B.Sc., F.L.S., in the " Journal of Botany," vol. 58, pp. 190-195 (1920).

Family RUBIACEÆ.

(By Spencer Le M. Moore, B.Sc., F.L.S., Dept. of Botany. British Museum of Natural History, London.)

Nauclea Chalmersii F. Muell. Pap. Pl., ii (viii), 44. Bisiatabu (357).

[**Uncaria pedicellata** Roxb. Boku, *Mrs. H. P. Schlencker.*]

[**U. appendiculata** Benth. B. N. Guinea (without precise locality), *W. E. Amit.*]

U. appendiculata Benth. Forma foliis pag. sup. fere glabris. Sogeri; and between Sogeri and Javararie.

[**U. Schlenckeræ** S. Moore, sp. nov.

Frutex scandens, pubescens; *ramis* sat validis optime tetragonis fulvo-pubescentibus; *foliis* brevipetiolatis ovatis basi rotundatis margine integris vel dentato-undulatis rigide membranaceis pag. sup. sparsim pag. inf. (in axillis costarum perspicue barbatis) dense fulvo-pubescentibus costis lateralibus utrinque circa 7 pag. inf. eminentibus; *stipulis* quam petioli longioribus ambitu late rotundatis medium usque bilobis pubescentibus lobis triangularibus obtusis; *pedunculo sterili* unico viso petiolis circa ter longiore pubescente; *pedunculis fertilibus* petiolis multo longioribus inferne incrassatis pubescentibus; *capitulis* multifloris; *floribus* pedicellatis uti ovarium calyxque dilute fulvo-tomentosis; *ovario* anguste ovoideo quam calycis pars libera indivisa longiore; *calycis* parte indivisa brevi cylindrica hujus lobis 5 (casu 6) linearibus obtusis vel anguste lineari-spathulatis quam pars indivisa longioribus extus pubescentibus; *corollæ* tubo subcylindrico ex calyce longe eminente extus pubescente lobis oblongo: obovatis obtusis tube multe brevioribus; *antheris* breviter exsertis, *stylo* longe exserto glabro stigmate anguste claviformi coronata; *capsula* anguste obovoideo-oblonga longitrorsum costata puberula.

Boku, *Mrs. H. P. Schlencker.*

Rami 3-4 mm. crass. Folia (perfecta haud obvia) circa 9-11 × 6·5-8·5 cm., in sicco pag. sup. atro-castanea, pag. inf. viridi-brunnea; petioli 5 mm. long. Stipulæ 1 cm. long. Pedunculus sterilis 1·5 cm., pedunculi fertiles 3-3·5 cm. long. Capitula 3 cm. diam. Pedicelli subflore 5-6 mm. sub fructu usque 9 mm. long. Ovarium 3 mm., calycis pars libera indivisa 1·25 mm., hujus lobi 2·25-2·5 mm. long. Corollæ tubus 8 mm. long., inferne ·5 mm, sub limbo usque 1 mm. gradatim ampliatus; lobi 2-3 mm. long. Antheræ 1·6 mm. long. Stylus 12 mm., stigma 2·5 mm. long.

Affinity with *U. velutina* Havil., which *inter alia* has quite different leaves and longer and narrower capsules.]

Uncaria sp. Deva Deva. Not identified, and may prove to be a new species characterised by the short pedicels (often united at bottom) and short young fruit, shorter indeed than the setaceous lobes of the calyx. The specimen is too incomplete for closer determination.

Wendlandia buddleacea F. Muell. Pap Pl. ii. (viii) 45. Astrolabe Range (296).

Hedyotis Auricularia Linn. Sogeri.

Hedyotis sp. On range between Sogeri and Javararie. Apparently a new species close to *H. pinifolia* Wall., distinguished from it chiefly by the very short corollatube, i.e. much shorter than the calyx (instead of longer than it as in *H. pinifolia*) and the small capsule.

Mussænda Whitei S. Moore, sp. nov.

Frutex ; ramulis sat validis breviter ferrugineo-tomentosis ; *foliis* ovatis breviter acuminatis apice acutis basi in petiolum aliquanto angustatis membranaceis supra subsparsim subtus dense pubescentibus costis lateralibus utrinque 10 uti costulæ inter costas more *Brideliarum* fere rectæ pag. inf. eminentibus pag. sup. parum perspicuis ; stipulis triangularibus bifidis facie utravis pubescentibus ; *cymis* terminalibus foliis circiter æquilongis e cymulis pluribus laxe ordinatis compositis ferrugineo-tomentosis ; *floribus* pro cymula pluribus breviter pedicellatis ; *bracteis* subulato-setaceis pubescentibus ; *ovario* cylindrico uti calycis segmenta lineari-setacea sordide albo-tomentoso ; *calycis* segmento foliaceo dum adsit ovata obtuso stipite brevi insidente utrinque pubescente albo ; *corollæ* parvæ tubo ultra medium gradatim sed leviter ampliato extus pilis fulvis appressis dense vestito lobis ovato vel oblongo-lanceolatis acutis pubescentibus ; *fructu* ———.

Mafulu (502).

Folia plerumque 7-10 $\times$ 4-6 cm. ; petioli 2-3 cm., stipulæ 7·5 mm. long. Cymæ usque circa 10 $\times$ 8 cm. Bracteæ $\pm$ 8 mm. long. Pedicelli circa 2 mm. long. Ovarium 4 mm., calycis segmenta 5-6 mm. long. ; hujus segmentum foliaceum 5 $\times$ 4 cm. stipite 7 mm. long. excluso. Corolla ex schedis cl. detectoris flava ; tubus 21 mm. long., inferne 1 mm. sublimbo 3 mm. lat. ; lobi 5 mm. long.

A very distinct species with its small corollas and short-stalked foliaceous calyx-segments among other features.

M. procera Bail. ? Bail. Queens. Agric. Journ., iii, 155 (1898). Astrolabe Range ; [Boku, *Mrs. H. P. Schlencker.*] No specimen of this either at the British Museum or at Kew. Not identified among New Guinea species in those collections.

M. frondosa Linn., var. **pilosissima** Engl. Sapphire Creek, Sent under the above name by Mr. White, but some doubt must attach to the determination ; I have seen no authentic dsecimen of this variety.

[**Mussænda** sp nov. ? Village of Tina, St Joseph River; Coll. ignot. Not identified: expanded corollas required for precise naming.]

Tarenna sp. Mekeo District (789). Specimen incomplete.

Gardenia ? sp. nov. Fofofofo. Quite unlike any Papuan species hitherto described. In absence of flowers, not desirable to describe. Seeds not immersed in pulp a peculiarity. (Almost certainly a *Gardenia*.)

Guettarda speciosa Linn. Port Moresby.

Timonius Rumphii DC. Port Moresby, and common on Astrolabe Range and Yule Island (17, 737). (Det. H. F. Wernham, D.Sc.)

T. cryptophlebus S. Moore, sp. nov.

Arbuscula, ramulis compressis subdistanter foliosis ferrugineo-tomentosis deinde glabrescentibus; *foliis* brevi-petiolatis oblongo-oblanceolatis obtusis basi breviter cuneatis chartaceis pag. sup. minute puberulis sublenteque striatulis sæpe confluentibus plus minus aspectabilibus copiose præditis pag. inf. præsertim in costa media hirsutulo-pubescentibus costis lateralibus uti reticulum pag. utriusque omnino vel fere omnino invisibilibus; *stipulis* ———— ; *floribus* pedicellis brevibus compressis ferrugineis insidentibus; *ovario* quam calyx breviter cupularis glaber longiore cylindrico paucisulcato fere glabro ∞-loculari; *corollæ* 5-meræ tube late cylindrico extus sordide albo-tomentoso lobis crassiusculis tubo brevioribus ovato-lanceolatis apice integris bifidisve vel etiam bipartitis; *antheris* 5 inclusis prope medium tubum insertis; *stylo* robusto glabro striis obviis percurso ramis 6 onustis.

Dilava (No. 428).

Folia in sicco brunnea, pleraque 7-10 × 3-4 cm., summa vero minora; petioli 1-1·5 cm. long., ferruginei. Pedicelli verisimiliter 5 mm. long. Ovarium 2-3 × 4 mm. Calyx 1-·15 mm. long. Corolla alba, humectata in toto 11 mm. long.; lobi soli 4 mm.; tubus 3 mm. lat. Antheræ sessiles, 3 mm. long. Stylus 4·5 mm., hujus rami 4 mm. long. Drupa (fortasse vix matura) eximie sulcata, fusca, 7 mm. diam.

The specimen is not wholly satisfactory, the few flowers and fruits being unattached, and stipules absent. Nevertheless without doubt it differs in several points from all described Papuan species. The striation of the leaves' upperside is a good deal like that of *T. avenis* Valet., as figured in Nova Guinea viii, t. lxxii.

Knoxia corymbosa Willd. F. Muell. Pap. Pl. i. (iii) 43. Sapphire Creek.

Ixora Whitei S. Moore, sp. nov.

Arbuscula ? glabra ; *ramulis* ultimis aliquante compressis distanter foliosis ; *foliis* brevipetiolatis oblongo-lanceolatis superne gradatim longiuscule acuminatis apice obtusis basi subrotundatis pergamaceis pallide nitidis glandulis translucentibus permultis microscopicis præditis costis lateralibus utrinque 18-22 angulis variis costæ centrali insertis pag. sup. vix pag. inf. (uti reticulum valde laxum) sat aspectabilibus ; *stipulis* parvis inferne ovatis in acumen brevem subito exeuntibus ; *panicula* terminali foliis circiter æquilonga angusta pedunculo elongato compresso insidente e cymulis paucis breviter pedunculatis paucifloris sistente hujus *ramis primariis* suboppositis ultimis alternis uti pedicelli abbreviati validi minute puberulis ; *bracteis* parvulis subulatis *ovario* pyriformi quam calyx cyathiformis minutissime 4-denticulatis longiore ; *alabastris* obtusis ; *corollæ* tubo angusto intus in faucibus glabro lobis 4 oblongis obtusis tubo æquilongis ; *antheris* subsessilibus acuminatis ; *stylo* pilosiusculo ramis linearibus onusto.

Mekeo District (798).

Folia 21-25 × 6·5-8·5 cm., in sicco grisea ; petioli validi, levissime torti, late canaliculati, 8-12 mm. long. Stipulæ pars lata 4 mm., acumen vix 2 mm. long. Panicula unica scrutata circa 20 × 4 cm. ; pedunculus ægre 13 cm. long. ; rami primarii 5-10 mm., bracteæ ± 2 mm. long. Pedicelli ± 1·5 mm. long. Ovarium 2 mm., calyx ·5 mm. long. Corollæ in sicco atræ tubus 8 × 1 mm. ; lobi 8 mm. long. Filamenta 2·5 mm., antheræ 7 mm. long. Stylus 11 mm., hujus rami 3 mm. long.

This is evidently close to *I. timorensis* Decne., its chief distinctive points being the lengthily acuminate leaves, the narrow inflorescence, and short thick pedicels to the flowers, together with the obtuse buds and broad corolla-lobes.

Morinda citrifolia Linn. Port Moresby (very common).

Psychotria decorifolia S. Moore, sp. nov.

Frutex glaber ; *ramis* compressis (deinde verisimiliter subtetragonis striatulatis crebro foliosis ; *foliis* brevipetiolatis elongatis lineari-lanceolatis longe gradatim acuminatis apice acutis basin versus leviter attenuatis basi obtusis punctis translucentibus minutis præditis pergamaceis costis lateralibus utrinque 16 pag. utravis inconspicuis ; *stipulis* majusculis ovatis fere usque medium in segmenta 2 anguste linearia divisis microscopice puberulis; *floribus* parvis breviter pedicellatis in paniculam cymosam subracemiformem foliis breviorem vel tandem subæquilongam minute pubescentem postea fere glabram digestis cymulis pro verticello 3-4 pedunculatis paucifloris; *ovario* cylindrico quam calyx cupularis 5-dentatus. paullulum longiore; *corolla* parva extus glabra intus in faucibus dense albo-lanata lobis 5 late oblongis obtusis quam tubus paullo brevioribus; *antheris* faucibus insertis vix exsertis; *disco* optime prominente; *stylo* glabro ramis obtusis microscopice papillosis; *fructu* late ovoideo calyce coronato cocco utroque facile partibili dorso alte 4-sulcato glabro.

Sapphire Creek (No. 135).

Folia 22-24 × 3·4-4 cm., in sicco grisea; petioli lati, 5 mm. long. Stipulæ 2·2 cm. long. (segmentis 1 cm. inclusis). Inflorescentia spec. alterius floriferi nobis obvii nondum profecto evoluta 7 cm. long., spec. alterius fructificantis 20 cm., hujus pedunculus vix 10 cm. long., rami primarii patentes cymulas sustinentes ± 1 cm. long.; pedicelli sub floribus ovario circa æquilongi quam fructus vero plane breviores. Ovarium ·75 mm., calyx ·5 mm. long. Corollæ albæ tubus 2·5 mm., lobi 2 mm. long. Stylus 2·2 mm. hujus rami ·4 mm. long. Fructus albus, 5 mm. long.

The foliage and stipules are the chief characters of this distinct species.

P. mafuluensis S. Moore, sp. nov.

Arbuscula glabra; *ramulis* validis compressis longitrorsum paucisulcatis; *foliis* majusculis petiolatis oblongo-obovatis apice subito cuspidato-acuminatis (acumine brevi acuto) basi cuneatis pergamaceis costis lateralibus pag. inf. optime eminentibus utrinque circa 20 a costa medio angulo fere recto abeuntibus leviter arcuatis; *stipulæ* late obovatis apice (anne semper?) bidentatis dentibus triangularibus obtusis; *paniculæ* terminali folia excedente laxe aperteque pauciramosa pedunculo valido compresso cymulis patentibus pro verticillo 2-3 laxe paucifloris ramis teneris insidentibus; *floribus* parvis pedicellatis; *ovario* turbinato calyce cupulari medium usque 5-lobo longiore; *corollæ* parvæ triente sup. in lobos 5 late oblongos obtusos divisæ tubo cylindrico intus villoso; *antheris* subsessilibus subexsertis; *disco* prominente; *styli* inclusi ramis obtusiusculis; *fructu* adhuc valde crudo ovoideo calyce discoque onusto.

Mafulu (No. 416).

Folia in sicco griseo-brunnea, 18-21 × 7·5-10·5 cm., petiolis validis 2-3 cm. long. exemptis. Stipulæ 13 × 11 mm., in sicco fusco-brunneæ. Inflorescentia 22 × 15 cm.; pedunculus 13 cm. long., uti rami ramulique albus; pedicelli quoad longitudinem valde dissimiles, ± 3 mm. long. Ovarium ægre 1 mm., calyx ·4 mm.. ong. Corolla alba; tubus 2·25 × 1 mm., lobi 1 mm. long. Antheræ 1 mm., stylus 1·5 mm. long., hujus rami ·75 mm. long. Fructus 3 × 2·3 mm.

In foliage very like *P. direpta* Wernh. except that the acumination is more sudden and the narrowed portion much shorter. Moreover the stipules are shorter and relatively broader as well as being bifid instead of entire. The flowers of *P. direpta* are unknown.

P. Whitei S. Moore, sp. nov.

Frutex novellis rufo-tomentosis; *ramulis* patentibus aliquanto compressis sursum foliosis rufo-tomentosis uti rami subteretes deinde glabrescentibus; *foliis* breviter petiolatis ellipticis acuminatis apice obtusis basi breviter cuneatim angustatis pergamaceis supra glabris subtus in costis rufo-tomentosis alibi sparsim pubescentibus costis lateralibus utrinque 12-15 pag. inf. optime prominentibus parum arcuatis; *stipulis* ovatis dorso rufo-tomentosis medium usque bilobis lobis triangularibus superne angustatis; *panicula* laxa terminali foliis breviore uti flores pedicellique pallide fulvo-tomentosa ramis primariis pro verticillo sæpius 4 cymulis ramulosis plurifloris ultimis corymbosis; *bracteis* parvis linearibus tomentosis; *ovario* subgloboso calyce longiore; *calycis* limbo 5-lobo lobis deltoideis obtusis; *corollæ* usque medium in lobos 5 oblongos obtusos divisæ tubo cylindrico intus in faucibus piloso; *stylo* glabro.

Dilava (No. 702).

Folia 13-15 × 4·5-6 cm., summa sæpissime 9-11 × 3·5-4·5 cm., horum acumen 1-1·5 cm. long., supra in sicco olivaceo-fusca; petioli 5-10 mm. long. Stipulæ 12-14 mm. long., inferne 7 mm. in transversum. Panicula 8-10 × 4 cm.; rami primarii infimi ± 17 mm. long., ascendentes. Bracteæ ± 2 mm. long. Pedicelli plerique ·5-1 mm. long. Ovarium ægre 1 mm., calyx ·5 mm. long. Corolla in toto 3·5 mm. long., tubus 1 mm. lat.

Affinity apparently with *P. rubiginosissima* Wernh., but entirely different in the foliage. In several particulars it answers the description of *P. Wichmannii*, Valet., but the venation of that species and the floral details are different.

Geophila reniformis D. Don. Javararie.

Amaracarpus cuneifolius Valet. (Det. by Dr. H. F. Wernham.) Dilava.

Hydnophytum sp. Koitaki (No. 409). Very close to *H. loranthifolium* Becc. but not quite conspecific. More flowers required for close determination.

FAMILY CUCURBITACEÆ.

Macrozanonia macrocarpa Cogn. R. A. Rolfe, Kew Bull. 1920, 197-199 ; *Bignoniaceæ*, F. M. Bail. in Proc. Roy. Soc. Queens., xviii, p. 2 (1904). Mekeo District.

Mukia scabrella Arn. F. Muell. Pap. Pl. i (iv), 68. Yule Island.

Luffa cylindrica Rœm. (*L. ægyptiaca* Mill.) ; F. Muell. Pap. Pl., i (iv), 68 ; Bail. Queens. Agric. Journ., xxiii, 221. Ethel River (Mekeo District).

FAMILY CAMPANULACEÆ.

Wahlenbergia gracilis A. DC. Mt. Warirata (Astrolabe Range). This plant is recorded by Mueller in Pap. Pl., ii (vi), 11, from Murray and Jervis Islands. Both these, however, are in Queensland territory.

FAMILY GOODENIACEÆ.

Scævola Lauterbachiana Krause. Astrolabe Range and Dilava [S. E. New Guinea, *H. O. Forbes*, ex Nat. Herb. Melb.].

S. novoguineensis K. Sch. Astrolabe Range ; Sogeri ; Mafulu [near Port Moresby, *Rev. W. G. Lawes*, ex Nat. Herb. Melb.].

FAMILY COMPOSITÆ.

Vernonia cinerea Less. F. Muell. Pap. Pl., i (ii), 27. Astrolabe Range ; Sogeri ; Mafulu.

Adenostemma viscosum Forst. F. Muell. Pap. Pl., i (iv), 69. Mafulu.

Ageratum conyzoides Linn. Port Moresby. A common weed.

Mikania scandens (Linn.) Willd. Sapphire Creek.

Erigeron linifolius Linn. F. Muell. Pap. Pl., i (iii), 44. Port Moresby. A very common weed.

Dichrocephala latifolia DC. *D. erecta* L'Her., F. Muell. Pap. Pl., ii (vi), 10. Mafulu.

Vittadinia brachycomoides F. Muell. Pap. Pl., ii (vi), 10; Vic. Nat. Feb. 1885. Astrolabe Range.

Blumea chinensis DC. Sapphire Creek and Mekeo District. A very common climber.

B. hieracifolia DC. F. Muell. Pap. Pl., i (v), 90. Yule Island.

B. lacera DC. Yule Island.

Pluchea indica Less. F. Muell. Pap. Pl., i (i), 10. Port Moresby. A very common beach shrub with strongly scented leaves and lavender-coloured flowers.

Pterocaulon cylindrostachyum C. B. Clarke. (*P. Billardieri*, F. Muell.); F. Muell. Pap. Pl., i (iii), 43.

Acanthospermum hispidum DC. Star Burr. Port Moresby. The plant is a great curse in Tropical Queensland.

Wedelia spilanthoides F. Muell. Port Moresby. A common weed in open forest country and native gardens.

Spilanthes Acmella Linn. Bisiatabu (Astrolabe Range).

Synedrella nodiflora Gærtn. Port Moresby. A common weed.

Bidens pilosa Linn. F. Muell. Pap. Pl., i (iii), 42. Cobbler's-pegs. Port Moresby. A common weed.

Crepis japonica Benth. F. Muell. Pap. Pl., ii (vi), 11. Bella Vista (ca. 5,000 ft.).

APPENDIX.

LORANTHACEÆ RECORDED FOR NEW GUINEA AND ADJACENT ISLANDS.

By W. F. Blakeley (Botanical Assistant, Botanic Gardens, Sydney).

Family LORANTHACEÆ.

Elytranthe Blume in Shults f. Syst., vii, 2.

Sect. ?

Elytranthe suberosa Laut. in Nov. Guinea, viii, pt. 4, 816 (1912). Dutch New Guinea, Biwak Hollandia (Humboldt-Bai.). Gjellerup No. 96, 30th April, 1910; No. 148, 28th May, 1910.

Sect. III.—Amylotheca van Tiegh.

E. Hollrungii K. Sch. in Fl. Kaiser Wilhelm's Land, 105 (1889). Engl. in Nach. ii, iv, Teil. 126 (1879). Allied to (*E. L.*) *dictyophleba*; Ramufluss (Tappenbeck No. 69, June 1898).

LORANTHUS L.

Subgenus I.—EULORANTHUS Engl.

Sect. I.—DACTYLOPHORA van Tiegh.

Loranthus verticellatus (Scheff.). Benth. et Hook. in Gen. Plant, iii, 208. (*Dendrophthœ verticellatus* Scheff., in Ann. Jard. Bot. Buitenz. i, 37.) Also recorded by Mueller in Descriptive Notes on Papuan Plants, i. (v) 99 (1875).

L. strongylophyllus Laut. in Nov. Guinea, Biwak, Hollandia (Humboldt-Bai.). Gjellerup No. 307, 18th Aug. 1910.

L. Versteegii Laut. in Nov. Guinea, viii, 289 (1910). Dutch New Guinea, Noord-Fluss, bei Alkmaar Urwald. (Versteeg. No. 1506, 23rd July, 1907); Noord Fluss, Biwak, Zwaluw, Uferwald (Versteeg, No. 1801, 8th Oct. 1907); Bian Fluss (Branderhost No. 278, 12th Dec. 1907). Manokœari, Miss L. S. Gibbs in Phytog. Fl. Arfak Mts. 210 (1917); South New Guinea, Geluks-Hugel. Urwald (V. Roemer No. 473, 7, 1909).

Sect. II.—HETEROSTYLIS Benth.

Series 1.—EUAMYEMA.

A. UMBELLULATI.

L. Friesianus K. Sch. in Schum & Lauterb.. Fl. Deutsch. Schutzg. Sudsee, 258 (1905). Kaiser Wilhelm's Land; Stephansort; Gestade (Nyman No. 41, 23rd Dec. 1898).

B. CYMULATI.

L. caudiciflorus Laut. in Nov. Guinea, viii, 290 (1910). Dutch New Guinea, Noord-Fluss, bei Gertenkamp (Versteeg No. 1473, July 1907).

L. pachypus Burkill in Kew Bull. 109 (1899). Allied to *L. pendulus* Sieb. Mt. Scratchley, 1,000-1,300 ft. [A. Guilianetti.]

Series ?

L. oxycladus Laut. et K. Sch. in Fl. Deut. Schutzg Sudsee, 298 (1901). Kaiser Wilhelm's Land; Suve-Mana bei Ssigdum-Jana, Hockwald. (M. Lauterbach No. 2276, June 1896); (Nuruflusse, No. 2328, June 1896); New Mecklenburg (Schlecter No. 14645, July 1902).

L. novæ-brittaniae Laut. in Nachtr. Fl. Deut. Sudsee, 259 (1905). Ins. Bismark, Neu-Pommern, bei Mandres (Schlecter No. 13765, Nov. 1901); Neu-Mecklenburg (Schlecter No. 14691). Peiana.

L. novæ guinæ Bail. in Ann. Rept. B.N.G. 1900-1, p. 144. Goodenough Island, *G. R. Le Hunte.*

Sect. X.—DIPLATIA van Tiegh.

L. Albertisii (van Tiegh) Engl. in Engl. & Prantl. Pflanzenf Nachtr. 1. 129. Recorded for New Guinea without specific locality. This species is allied to *L. grandibracteus* F. v. M.

Subgenus II.—DENDROPHTHŒ Mart.

Series 2.—CICHLANTHUS Engl.

L. diversifolius Ridl. in Trans. Linn. Soc. Lond. (Bot.) vol. ix, pt. i, p. 146 (1916). Dutch New Guinea, Camp III to IX, 2,500 to 5,500 ft. Wollaston Expedition.

L. hastifolius Ridl. l.c. Camp VII to VIII, 3,660 to 4,900 ft. Wollaston Expedition.

Series 3.—EUDENDROPHTHŒ.

L. longiflorus Desr. Neu Pommern, Bei Massawa (Schlecter No. 13741, 1901) ; South New Guinea, Flachland, Urwald (V. Roemer No. 473, Sept. 1909) ; Kaiser Wilhelm's Land ; Halzfelden (Hollrung No. 342) ; Augusrafluss (Hollrung No. 662) ; Ramufluss (Tappenbach No. 114, 14th July, 1898). Dutch New Guinea ; Wollaston Expedition, Camp III, 2,500 ft. ; Ridl. Bot. Woll. Exped. Trans. Linn. Soc. Lond. 2 ser., vol. ix, pt. 1, p. 146 (1916).

Series ?

L. dolichocladus K. Sch. in Nach. Fl. Deutsch. Sudsee, 258 (1905). Kaiser Wilhelm's Land and Frederick Wilhelmshafen (type locality) ; (Nyman No. 1068, Sept. 1899). Dutch New Guinea, Sudkuste bei Merauke, Alagfalern (Versteeg No. 1909, Nov. 1907).

L. Lauterbachii K. Sch. in Fl. Deutsch. Sudsee, 299 (1901). Kaiser Wilhelm's Land, Am Huon-Golf bei Kap Ankona (Lauterbach No. 666, Aug. 1890—the type). Dutch New Guinea, Noord-Fluss (Versteeg No. 1798, Oct. 1907, No. 1033, March 1907).

L. Gjellerupii Laut. in Nov. Guinea, viii, 815 (1912). Dutch New Guinea, Biwak Hollandia (Humboldt-Bai Seestrand Gjellerup No. 143, May 1910).

L. Seemenianus K. Sch. in Fl. Kaiser Wilhelm's Land, 106 (1889). Seestrand von Halyfeldthafen (Hollrung No. 345, Oct. 1887).

L. Balmeri Laut. et K. Sch. in Fl. Deut. Schutzg Sudsee 278 (1901). Kaiser Wilhelm's Land, Sattelberg (Balmer No. 16).

L. finisteriæ Warb. in Bergpfl. 13, 20 (1892). Kaiser Wilhelm's Land, Finisterre-Gebirge (Hellwig No. 322, Oct. 1888).

Loranthus sp. near *L. alyxifolius* F. v. M. Recorded by Bailey in Queens. Agric. Journ., vii, 349.

Loranthus sp. Valeton, Bull. Dept. d. l. Agric. Ind. Neerland. x, 7.

FAMILY VISCOIDEÆ.

NOTOTHIXOS Oliv.

Sect. I.—EUNOTOTHIXOS van Tiegh.

Notothixos leiophyllus K. Sch. Nach. Fl. Deutsch. Schutz. Sudsee, 260 (1905). Bismark-Archipel New Pommern (*R. Parkinson,* No. 105 (1885)). This is the plant referred to by Mueller in Notes Papuan Plants, ii (7), 29 (1886), under *N. subaureus*, "in a large-leaved state with more elongated inflorescence"; and also in Pap. Pl., ii, 61, and Linn. Soc., vol. ii, n.s., p. 422. Base of Owen Stanley Ranges, British New Guinea (*H. O. Forbes*, No. 779 (1885-6)).

I am indebted to Professor Ewart, of the Melbourne Herbarium, for the loan of the last three specimens.

VISCUM L.

Sect. I.—PLOINIXIA Korth.

Series I.—ISANTHEMUM van Tiegh.

Viscum orientale Willd. is recorded for Papua by Mueller in Descriptive Notes on Papuan Plants, p. 99 (1875), who quoted Scheffer's record in Bot. Gard. Buitenzorg. vi, p. 27. Scheffer's record is as follows (*V. orientale* Willd. Miq. l.c. p. 804) :—I have not seen this specimen and therefore cannot say if it is the same as *V. verruculosum* Wight & Arn. C. Lauterbach in Flora Nov. Guinea, vol. viii, pt. iv, p. 816 (1912), records it for Dutch New Guinea : Biwak Hollandia (Humboldt-Bai) on sea-strand (Gjellerup No. 105, Feb. and April (1910)).

Sect. II.—ASPIDIXIA.

V. angulatum Heyne. Islands on the south coast of New Guinea (*Rev. J. Macfarlane* 1885), Mueller in Notes Papuan Pl. ii (ix), 29 (1886). According to Professor Ewart this species is not represented in the Papuan collection in the Melbourne Herbarium.

Principal Bibliography of Works on the Flora of the Territory of Papua (British New Guinea).

1875-1877. MUELLER, Baron FERD. VON.—Descriptive Notes on Papuan Plants. Pts. i-v forming vol. i. Pts. vi-ix, forming the first four parts of vol. ii, were issued from 1885 to 1890. The volume was not completed nor an index issued.

1877-1890. BECCARI, O.—Malesia, vols. i, ii, and iii. Contains descriptions of a few of D'Albertis' plants from the Fly River.

1880. BECCARI, O.—Notes on Plants Collected by Sig. L. M. D'Albertis in New Guinea, in "New Guinea" by D'Albertis, pp. 391-400. All the plants listed are from the Fly River.

1882. MUELLER, Baron FERD. VON.—A Gesneriaceous Plant discovered in New Guinea. Wing's "Southern Science Record," vol. ii, p. 229.

1884-5. MUELLER, Baron FERD. VON.—Several small papers in the Melbourne "Chemist and Druggist."

1884-1896. MUELLER, Baron FERD. VON.—Miscellaneous Papers in the "Victorian Naturalist," vols. i-xiii.

1885. MUELLER, Baron FERD. VON.—Descriptive Notes on Papuan Plants. Two papers in "The Australasian Scientific Magazine."

1885-1886. MUELLER, Baron FERD. VON.—Several Papers in Wing's "Southern Science Record," vols. i and ii (new series).

1886. RIDLEY, H. N.—On the Monocotyledonous Plants of New Guinea, collected by Mr. H. O. Forbes. Journ. Botany, vol. xxiv pp. 321-327 and pp. 353-360.

1886-7. MUELLER, Baron FERD. VON.—Several small papers in the "Australasian Journal of Pharmacy."

1887. MUELLER, Baron FERD. VON.—Report on a Small Collection of Plants from the Aird River, obtained by Mr. Theodore Bevan. Proc. Linn. Soc. N.S.W., vol. ii, n.s., pp. 419-422.

1887. MAIDEN, J. H.—Notes on Some Indigenous Sago and Tobacco from New Guinea. Proc. Linn. Soc. N.S.W., vol. ii, n.s., pp. 457-466.

1888-1896. MUELLER, Baron FERD. VON.—Papers in Annual Reports, British New Guinea.

1889. MUELLER, Baron FERD. VON.—Records of Observations on Sir Wm. MacGregor's Highland Plants from New Guinea. Trans. Roy. Soc. Vic., vol. i, pt. 2, pp. 145.

1892. Succinct General Notes on the Flora of British New Guinea. Appendix ii to J. P. Thomson's "British New Guinea," pp. 218-221.

1891-3. MUELLER, Baron FERD. VON.—Notes on Papuan Plants. Three papers in the "Journal of Botany," vols. xxix-xxxi.

1896. BAILEY, F. M.—Additions to the New Guinea Flora. Botany Bulletins xiii and xiv (Queensland Dept. Agriculture), pp. 14-16

1897-1914. BAILEY, F. M.—Contributions to the Flora of British New Guinea. A series of papers published in the "Queensland Agricultural Journal."

1898. BAILEY, F. M.—Names of Easily Recognised Plants observed by Lord Lamington's Party during New Guinea Expedition. Appendix (pp. 27-28) of Parliamentary Paper "Report of Visit to British New Guinea."

1898. HEMSLEY, W. B.—Report on Botanical Collections. Annual Report British New Guinea 1897-8, pp. 147-150.

1899. BAILEY, F. M.—Notes on the Vegetation of New Guinea. Proc. Roy. Soc. Queensl., xiv, pp. 14-20.

1899. HEMSLEY, W. B., and others.—Flora of British New Guinea. Kew Bull. 1899, pp. 95-126.

1899-1901.—BAILEY, F. M.—Papers in Annual Reports, British New Guinea (reprinted from the "Queensland Agricultural Journal").

1904. BAILEY, F. M.—Contributions to the New Guinea Flora. Proc. Roy. Soc. Queensl., xviii, pp. 1-5.

1905. SCHUMANN, K., and LAUTERBACH, K.—Nachträge Flora Deutsch. Schutzgeb. Sudsee. Contains a few references to plants from British New Guinea.

1908. BURNETT, GILBERT.—Timber Trees of the Territory of Papua (Issued by the Dept. of External Affairs, Melbourne).

1911. COPELAND, E. B.—Papuan Ferns collected by the Rev. Copland King. Philippine Journ. Science. Bot., vol. vi, pp. 65-92.

1912-1916. LAUTERBACH, SCHLECHTER, and others.—Beiträge zur Flora von Papuasien, i-v. Contains many references to plants from British New Guinea.

1916. RIDLEY, H. N., and others.—Report on the Botany of the Wollaston Expedition to Dutch New Guinea. Trans. Linn. Soc. (Bot.), vol. ix, pp. 1-269. Contains a few odd references to plants from British New Guinea.

1918. WERNHAM, H. F.—Dr. H. O. Forbes's New Guinea Rubiaceæ. Journ. Bot., vol. lvi, pp. 68-77 and pp. 129-135.

1922. DIXON, H. N.—The Mosses of the Wollaston Expedition to Dutch New Guinea 1912-13, with some additional Mosses from British New Guinea.—Jour. Linn. Soc. (Bot.), vol. xlv, pp. 477-510.

Marine Mollusca from New Guinea.

By John Shirley, D.Sc., F.M.S., Corresponding Member, Royal Society of Tasmania; Honorary Member, Pharmaceutical Society of Queensland.

(Read before Royal Society of Queensland, 11th April, 1922.)

In a recent visit to New Guinea, Professor J. V. Danes, Ph.D., Consul-General for Czecho-Slovakia, travelled in British Papua, and in the mandated territory lately known as German New Guinea. He was accompanied by his charming and accomplished wife, who at Samarai, Gurya Beach, Rabaul, and Port Moresby made collections of marine shells. These were submitted to me for determination, and a classified list is shown herewith. As the time spent at each place of call was limited, few of the smaller species were gathered, and the list reveals few novelties.

The first collection of New Guinea Mollusca seems to have been made in 1842-6, when H.M.S. "Fly," under Captain F. R. Blackwood, was employed in surveying the North Australian and South Papuan coasts. On board this ship was Dr. J. Beete Jukes, who diligently searched for mollusca on all possible occasions. His collections were described mainly by Arthur Adams and Lovell Reeve, while Dr. J. E. Gray dealt with certain important discoveries in an appendix to Jukes's narrative.

This survey was continued and extended by H.M.S. "Rattlesnake" in 1849-50, when the Louisiade Islands were visited and collections made, to be afterwards described by Forbes in an appendix to MacGillivray's account of the voyage. The "Challenger" while in Torres Strait, at Station 188, on 10th September, 1874, dredged off south-west of Papua. An expedition organized in 1875 by Sir William Macleay left Sydney in the "Chevert," having on its scientific staff such well-known Australian workers as Messrs. Brazier, Masters, Petterd, and Spalding; and called at Yule Island where Brazier gathered many new species of shells, whose descriptions, with those from Australian localities, will be found in his numerous papers in series 1, vols. 1 and 2 of the Linnean Society's Proceedings,[1] New South Wales. During 1875 and following

[1] *See also* vol. ix, pp. 988-992, and vol. x, pp. 841-4, first series.

years, D'Albertis obtained at Yule Island and the Fly River a great supply of conchological material, that was submitted to Tapparone-Canefri, and published in the Annali del Museo Civico di Genova, vol. xix, first series, and iv, second series.

Mr. A. Goldie, a trader and collector, travelled extensively in south-eastern New Guinea, and collected land and marine shells, that went mainly to the British Museum, and were described by the late E. A. Smith in the Annals and Magazine of Natural History. Professor A. C. Haddon, during his expedition to Torres Strait, on 17th August, 1888, dredged in the channel between Saibai and New Guinea. His molluscan gatherings were submitted to Messrs. Melvill and Standen, who published their results in the Journal of the Linnean Society, London, vol. xxxvii, 1899, pp. 150-206, with two plates.

A collection made by Sir William Macgregor in the Louisiades in 1889 was also sent to the conchologist of the British Museum for naming and describing. In 1890 Mr. Charles Hedley of the Sydney Museum was in New Guinea for three months, the guest of Sir William Macgregor. He was given opportunities to visit Milne Bay, Samarai, Port Moresby, and St. Joseph's River, mainly in search of land shells. His gatherings are described in the Proceedings of the Linnean Society of New South Wales, vol. vi, second series, 1891, pp. 67-116; and vol. ix, pt. 2, pp. 384-92.

Papers on species of *Chloritis*, by S. K. Gude, including some from New Guinea and neighbouring islands, will be found in the Proceedings of the Malacological Society, vol. vii. pt. 1, pp. 44-48, and pt. 2, pp. 105-8.

Sub-Kingdom MOLLUSCA.

Class PELECYPODA (1–35).

Order PRIONODESMACEA (1–15).

Family ARCIDÆ.

Arca, Linné Syst. Nat., x, 1758, p. 693.

1. *Arca chalcantha* Reeve. 3.
2. *Arca fusca* Bruguieres. 1.
3. *Arca imbricata* Bruguieres. 2.
4. *Arca lima* Reeve. 3.
5. *Arca trapezia* Deshayes. 1, 2, 3.

The numerals after the species refer to the following localities:—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

GLYCIMERIS da Costa, Brit. Conch., 1778, p. 168.

6. *Glycimeris montrouzeri* Angas. 1.

7. *Glycimeris pectunculus* Linné = *pectiniformis*, Lamarck. 1.

8. *Glycimeris reevei* Mayer = *angulata* Reeve. 1.

FAMILY PERNIDÆ.

PERNA Bruguieres, 1792.

9. *Perna sulcata* Lamarck. 1.

FAMILY PECTENIDÆ.

CHLAMYS Bolten, Mus. Bolten, 1798, p. 161.

10. *Chlamys pallium,* Linné. 1.

FAMILY SPONDYLIDÆ.

SPONDYLUS Linné, Syst. Nat., x, 1758, p. 690.

11. *Spondylus depressus* Fulton. 1, 3.

12. *Spondylus hystrix* Bolten *non* Reeve. 1, 2.

13. *Spondylus nicobaricus* Chemnitz. 1.

MODIOLUS Lamarck, Mem. Soc. N. H. Paris, 1799, p. 87.

14. *Modiolus philippinarus* Hanley. 4.

SEPTIFER Recluz, Rev. Zool., 1848, p. 275.

15. *Septifer bilocularis,* Linné. 3.

ORDER TELEODESMACEA (16-35).

FAMILY CARDITIDÆ.

CARDITA Bruguieres, Encyc. Meth. vers (2), 1792, p. 401.

16. *Cardita variegata* Bruguieres. 1.

FAMILY CHAMIDÆ.

CHAMA Linné, Syst. Nat., x, 1758, p. 691.

17. *Chama pacifica* Brod. 3.

The numerals after the species refer to the following localities:—
1 Samarai, 2 Guyra Beach, 3 Rabaul, 4 Port Moresby.

Family LUCINIDÆ.

Corbis Cuvier, Regn. Anim., ii, 1817, p. 480.

18. *Corbis fimbriata* Linné. 4.

Family CARDIIDÆ.

Cardium Linné, Syst. Nat., x, 1758, p. 678.

19. *Cardium reevianum* Dunker. 1, 2, 3.

Family TRIDACNIDÆ.

Tridacna Bruguieres, 1789.

20. *Tridacna crocea* Lamarck. 2.

Hippopus Linné, Syst. Nat., x, 1758, p. 691.

21. *Hippopus hippopus* Linné. 1, 3, 4.

Family VENERIDÆ.

Lioconcha Mörch, Cat. Yoldi, ii, 1853, p. 26.

22. *Lioconcha castrensis* Linné. 1, 2.

Gafrarium Bolten Mus Bolt., 1798, p. 176.

23. *Gafrarium australis* Sowerby. 3.
24. *Gafrarium australica* Reeve. 1, 3, 4.
25. *Gafrarium pectinatum* Linné. 2, 3, 4.
26. *Gafrarium tumidum* v. *ranellum* Lamarck. 2, 3.

Antigona Schumacher, Essai Nouv. Syst., 1817, p. 51.

27. *Antigona puerpera* v. *gladstonensis* Menke. 1.
28. *Antigona toreuma* Gould. 2.

Paphia Bolten, Mus. Bolt., 1798, p. 175.

29. *Paphia variegata* Bruguieres. 1.

Family PLEUROPHORIDÆ.

Trapezium Desh. Trait. Ellem. Conch., ii, p. 18.

30. *Trapezium angulatum* Lamarck. 1.

The numerals after the species refer to the following localities :—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

Family TELLINIDÆ.

Tellina Linné, Syst. Nat., x, 1758, p. 674.

31. *Tellina virgata.* 3.

Family GARIDÆ.

Asaphis Modeer, K. Vet. Ac. Nya Handl. xiv, 1793, p. 176.

32. *Asaphis deflorata* Linné. 1, 3, 4.

Family AMPHIDESMATIDÆ.

Amphidesma Lamarck, An. s. vert., v, 1818, p. 489.

33. *Amphidesma plana* Hanley. 1, 3.
34. *Amphidesma striata* Gmelin. 1, 2, 3.

Family CORBULIDÆ.

Corbula Brug., Encyl. Meth., 1797, tab. vers. pl. 230.

35. *Corbula scaphoides* Hinds. 3.

Class GASTEROPODA (36–135).

Order DIOTOCARDIA (36–57).

Family HALIOTIDÆ.

Haliotis Linné, Syst. Nat., x, 1758, p. 779.

36. *Haliotis varia* Linné. 1.

Family TROCHIDÆ.

Monodonta Lamarck, Mem. Soc. N. H. Paris, 1799, p. 74.

37. *Monodonta tuberculata* A. Ad. 2.

Trochus Linné, Syst. Nat., x, 1758, p. 756.

38. *Trochus obeliscus* Linné. 1.
39. *Trochus venustus* Reeve. 1.

Family TURBINIDÆ.

Turbo Linné, Syst. Nat., x, 1758, p. 761.

40. *Turbo chrysostomus* Linné. 1.
41. *Turbo intercostalis* Menke. 1.
42. *Turbo petholata* Reeve. 1.
43. *Turbo porphyrites* Martyn. 1.
44. *Turbo radiatus* Gmelin. 1.

The numerals after the species refer to the following localities :—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

ASTRÆA Bolten, Mus. Bolt., 1798, p. 79.

45. *Astræa hæmotraga* Menke. 1.
46. *Astræa nobilis* Gray. 1.

CHRYSOSTOMA Swainson, 1840.

47. *Chrysostoma paradoxam* Born. 1.

FAMILY NERITIDÆ.

NERITA Linné, Syst. Nat., x, 1758, p. 776.

48. *Nerita albicilla* Linné. 1, 2.
49. *Nerita costata* Chemnitz. 1.
50. *Nerita planispira* Anton. 1.
51. *Nerita plicata* Linné. 1.
52. *Nerita polita* Linné. 1, 2.
53. *Nerita polita* v. *rumphii* Recluz. 1.
54. *Nerita signata* Macleay. 2, 3.
55. *Nerita reticulata* Karstens. 1.
56. *Nerita* [2]*semirugata* ? Recluz. 3.
57. *Nerita undata* Linné. 1, 3.

ORDER MONOTOCARDIA (58–135).

SUBORDER TÆNIOGLOSSA (58–96).

FAMILY LITTORINIDÆ.

MELARAPHE Menke, Syn. Meth. Moll., 1828, p. 45.

58. *Melaraphe scabra* Linné. 2.
59. *Melaraphe scabra* v. *sinensis* Philippi. 2.

FAMILY PLANAXIDÆ.

PLANAXIS Lamarck, 1822.

60. *Planaxis sulcatus* Born. 3.

FAMILY HIPPONICIDÆ.

HIPPONIX Defrance, Bull. Soc. Philom., 1819, p. 8.

61. *Hipponix barbatus* Sowerby. 1.

FAMILY CAPULIDÆ.

CAPULUS Montfort, Conch. Syst., ii, 1810, p. 55.

62. *Capulus tricarinatus* Linné. 3.

The numerals after the species refer to the following localities :—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

[2] These shells agree completely with specimens so named by Brazier; and with f. 41, plate 3, vol. x of Tryon; but differ in outline and lip details from f. 42 of the same plate.

Family CERITHIIDÆ.

Cerithium Bruguieres, Encyc. Meth. vers (1), 1789, p. xv.

63. *Cerithium gemmulatum* Hinds. 1.
64. *Cerithium gemmulatum* v. *articulatum* H. & A Adams. 1.
65. *Cerithium janelli* H. & J. 2.
66. *Cerithium janelli* v. *moniliferum* Sowerby. 2.

Family STROMBIDÆ.

Strombus Linné, Syst. Nat., x, 1758, p. 742.

67. *Strombus dentatus* Linné. 1, 3, 4.
68. *Strombus gibberulus* Linné. 2.
69. *Strombus luhuanus* Linné. 1, 2.
70. *Strombus minimus* Linné. 3, 4.

Family CYMATIIDÆ.

Cymatium Bolten, Mus. Bolt., 1798, p. 129.

71. *Cymatium testaceum* Mörch. 1.

Family CASSIDIDÆ.

Phalium Link, Rostock Samml., iii, 1807, p. 112.

72. *Phalium vibex* Linné. 3.

Family NATICIDÆ.

Natica Scopoli, Intr. Hist. Nat., 1777, p. 392.

73. *Natica deidosa* Reeve. 1.
74. *Natica flemingiana* Recluz. 1.
75. *Natica gualteriana* Recluz. 2.
76. *Natica mamilla* Reeve. 2.
77. *Natica* [3]*mozaica* Sowerby. 3.

Polinices Montfort, Conch. Syst., ii, 1810, p. 222.

78. *Polinices filosa* Sowerby. 2.

Family MODULIDÆ.

Modulus Gray, 1840.

79. *Modulus tectum* Gmelin. 1.

The numerals after the species refer to the following localities :—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

[3] Only one specimen was included in Madame Danes's collection ; it is typical in size and shape, but the first circle of spots on the body-whorl is more distant from the second one than is usual.

FAMILY CYPRÆIDÆ.

CYPRÆA Linné, Syst. Nat., x, 1758, p. 718.

80. *Cypræa annulus* Linné. 2, 3, 4.
81. *Cypræa asellus* Linné. 1.
82. *Cypræa caput-serpentis* Linné. 1.
83. *Cypræa caurica* Linné. 1.
84. *Cypræa cicerula* Gmelin. 1, 3.
85. *Cypræa erosa* Linné. 1, 3, 4.
86. *Cypræa errones* Linné. 1, 3.
87. *Cypræa felina* Gmelin. 1.
88. *Cypræa interrupta* Gray. 1.
89. *Cypræa isabella* Linné. 1, 2, 3.
90. *Cypræa lynx*. 1, 2, 3.
91. *Cypræa moneta* Linné. 1, 3.
92. *Cypræa neglecta* Sowerby. 1, 2.
93. *Cypræa nucleus* Linne. 1, 2.
94. *Cypræa quadrimaculata* Gray. 1, 2.

TRIVIA Broderip, Penny Cycl., viii, 1837, p. 256.

95. *Trivia insecta* Mighels. 1.
96. *Trivia oryza* Lamarck. 1, 2.

SUBORDER STENOGLOSSA (97–135).

FAMILY OLIVIDÆ.

OLIVA Bruguieres, Encyc. Meth. vers, i, 1789, p. xv.

97. *Oliva australis* Ducloz. 3.
98. *Oliva bulowi* Sowerby. 3.
99. *Oliva carneola* Gmelin. 3.
100. *Oliva duclosi* Reeve. 3.

No. 98. A shell of 8 whorls, having the general shape of *O. australis* Ducl., and an average specimen measuring 23 cm. × 10 cm. The mouth is 17 cm. × 5 cm., but unlike *australis* its posterior canal is closer to the body-whorl. The ground colour is tawny yellow, marked by faint chestnut-coloured spots on the upper half of the body-whorl; these increase in size and depth of colour, and form zigzag streaks below.

No. 100. Very closely resembles *O. ispidula* L., of which it may be a variety. It differs in size, being usually smaller, and in the shape of the mouth. In *ispidula* the space between the two lips widens gradually from above downward. In *duclosi* for two-thirds of the length the lips are nearly parallel. Then the inner lip slopes rapidly. The ground colour of the shell is lighter, and the striations on the columella more numerous.

The numerals after the species refer to the following localities :—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

Family CONIDÆ.

Conus Linné, Syst. Nat., x, 1758, p. 712.

101. *Conus achatinus* Chemnitz. 1.
102. *Conus auratus* Lamarck. 1.
103. *Conus ceylonensis* v. *nanus* Brot. 1.
104. *Conus emaciatus* Reeve. 1.
105. *Conus glans* Hwass. 1.
106. *Conus hebræus* Linné. 1.
107. *Conus militaris* Hwass. 1.
108. *Conus musicus* Hwass. 1.
109. *Conus mussatella* Linné. 1.
110. *Conus omaria* Hwass. 1.
111. *Conus* [4]*pulchellus* Swainson. 1.
112. *Conus rattus* Hwass. 1, 2, 3.
113. *Conus stercus-muscarum* Linné. 1.
114. *Conus* [5]*varius*, Linné. 1.

Family TURRIDÆ.

Drillia Gray, 1838.

115. *Drillia digitalis* Reeve. 1.

Family TURBINELLIDÆ.

Latirus Montfort, 1810.

116. *Latirus turritus* Gmelin. 3.

Peristernia Mörch, 1852.

117. *Peristernia nassatula* Lamarck. 1.

Vasum Bolten, 1798.

117a. *Vasum armigerum* Brod. 1.

The numerals after the species refer to the following localities:—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

[4] The specimen from Samarai resembles f. 78 of plate 14 of Tryon's Manual in size, spire, and markings, except that the central light band is more definite and complete.

[5] A rare shell on the Queensland coast and seldom collected in a perfect condition. The New Guinea specimen agreed in outline, in the tubercles on the spire, and showed the remains of the grooves on the lower half of the body-whorl. The ground colour was white, with remains of chestnut patches.

Family MITRIDÆ.

MITRA Martyn, Univ. Conch., 1784, Expl. to p. 19.

118. *Mitra amanda* Reeve. 1.
119. *Mitra auriculoides* Reeve. 1.
120. *Mitra cucumerina* Linné. 1.
121. *Mitra paupercula* Linné. 2.
122. *Mitra tabanula* Lamarck. 1.
123. *Mitra rufescens* A. Adams. 2.
124. *Mitra stictica* Link = *cardinalis* v. *pertusa* Sowerby.

Family BUCCINIDÆ.

CANTHARUS Bolten, 1798.

125. *Cantharus rubiginosus* Reeve. 1.

Family NASSARIIDÆ.

NASSARIUS Froriep in Dumeril, Zool. Analyt., 1806, p. 167.

126. *Nassarius jonasi* Dunker. 3.

Family PYRENIDÆ.

PYRENE Bolten, Mus. Bolt., 1798, p. 134.

127. *Pyrene fulgurans* Lamarck. 1.
128. *Pyrene punctata* Bruguieres. 1, 2.
129. *Pyrene versicolor* Menke. 1.
130. *Pyrene Zelina* Ducloz. 1.

Family MURICIDÆ.

MUREX Linné, Syst. Nat., x, 1758, p. 746.

131. *Murex australiensis* A. Adams. 1.

Family THAIDIDÆ.

THAIS Bolten, Mus. Bolt., 1798, p. 54.

132. *Thais ambustulata* Hedley. 1.
133. *Thais pica* Blainville. 1.

The numerals after the species refer to the following localities :—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

DRUPA Bolten, Mus. Bolt., 1798, p. 55.

134. *Drupa mora* Bolten. 1.

135. *Drupa ochrostoma* Blainville. 2.

SUBORDER PULMONATA (136–142).

FAMILY ELLOBIIDÆ.

PYTHIA Schumacher, 1817.

136. *Pythia argenvillei* Pfeiffer. 3.

137. *Pythia pantherina* A. Adams. 4.

RHODOSTOMA Swainson, Proc. Roy. Soc., V.D. Land, iii, 1855, p. 44.

138. *Rhodostoma nucleum* Martyn. 2.

MELAMPUS Montfort, 1840.

139. *Melampus lividus* Deshayes. 2.

FAMILY SIPHONARIIDÆ.

SIPHONARIA Sowerby, Genera of Shells, 1824, fasc. xxi.

140. *Siphonaria acuta* Quoy & Gaimard. 1.

141. *Siphonaria atra* Quoy and Gaimard. 1.

142. *Siphonaria zebra* Reeve. 1.

SUBORDER OPISTHOBRANCHIA (143–144).

FAMILY SCAPHANDRIDÆ.

ATYS Montfort, 1810.

143. *Atys cylindrica* Helbling. 4.

FAMILY AKERIDÆ.

BULLARIA Rafinesque, Anal. Nat, 1815, p. 142.

144. *Bullaria adamsi* Menke. 1, 2.

The numerals after the species refer to the following localities:—
1 Samarai, 2 Gurya Beach, 3 Rabaul, 4 Port Moresby.

Notes on the Biology of some of the More Common Queensland Muscoid Flies.

By Professor T. HARVEY JOHNSTON, M.A., D.Sc., and O. W. TIEGS, M.Sc., formerly Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(*Read before Royal Society of Queensland, 28th April, 1922.*)

The main object of the present paper is to place on record the results of a series of observations which aimed at determining the duration of the various stages of the life-cycle of some of the common Queensland Muscoid flies. Amongst those dealt with are the housefly; a number of blowflies including certain sheep maggot-flies; some species of *Sarcophaga* and *Musca*; and the stable fly *Stomoxys*.

Observations were recorded regarding the following:—Length of time taken by the egg to hatch; period during which the larva fed; time intervening between the cessation of feeding and the undergoing of obvious pupation (larval resting period or prepupal stage); length of time passed in the pupal condition; time elapsing between the deposition of a larva or egg and the emergence of the imago resulting from such larva or egg; the period between emergence and sexual maturity of the female as evidenced by the act of copulation (maturation period); time between emergence of the female and oviposition by it (preoviposition period); longevity of the adult in captivity.

The egg period was always obtained by observing the fly actually ovipositing and watching till the eggs hatched, the time being noted in hours. No attempt was made to ascertain the length of time passed in the various larval instars. The resting period was regarded as commencing when the larvæ began to leave their food material and to wander. This wandering is a marked characteristic of some of the species—e.g. *Lucilia* larvæ are capable of travelling many yards from the place of feeding until they find a suitable patch of soil in which to pupate; while *Chrysomyia albiceps* and *Sarcophaga* spp. likewise may wander for a considerable distance; on the other hand *Ophyra nigra* generally bores into the soil directly beneath, or in close proximity to, its feeding place.

Male flies appear to be sexually mature soon after emergence from the puparium, but females usually take some time to reach maturity, the time being reckoned as from the date when copulation was observed to occur, as this no doubt takes place soon after the flies are mature. The determination of the length of adult life of the various flies, as recorded in this paper, is not very satisfactory since the insects had necessarily to be kept in confinement from the time of their emergence. Food, temperature, moisture, etc., all influence this period.

There are unfortunately numerous blanks in the tables given in this paper, some of them owing to the fact that a number of the flies would not copulate in captivity, though they were flying about in a large room with abundant bright and shady places in it. During the summer it was found possible to carry out monthly observations, but this could not be done in the winter, owing to the difficulty of obtaining suitable species when needed. As the length of the various periods in the case of *Lucilia* was ascertained to be fairly constant during the several winter months, it has been considered sufficient in most cases to record observations during the winter period (May to September) without specifying any particular months.

A curious fact noted was that while *all* the species of carrion-flies could be obtained during any month yet many species had a period during which they gradually increased in numbers relatively and eventually predominated over the other species.

The observations to be referred to, unless otherwise stated, were carried out in Brisbane from the beginning of September 1920 till the end of August 1921, i.e. a full year. Some observations made by Miss Bancroft in Eidsvold (Upper Burnett River) and in Brisbane during 1919 and early in 1920, in connection with work carried out in collaboration with the senior author, are included. Certain data presented in this paper were briefly referred to in an article by one of us last year (Johnston 1921).

Froggatt and Froggatt (1916, p. 9) have published a statement regarding the average number of eggs found in the ovaries of various blowflies in New South Wales. The larval stages of some of the flies referred to in this paper have been described recently by Sinton (1921), while short accounts were published some years ago by Messrs. W. W. and J. L. Froggatt. The dipterous larvæ which produce myiasis in man and domesticated animals have been reviewed by Patton (1921).

Lucilia sericata Meigen.

The fly to which this name is attached in Australia is very common during summer, being prevalent in the vicinity of houses. It is frequently seen in winter in Queensland, increasing in numbers gradually until it becomes the dominant blowfly in December. It is one of the sheep maggot-flies. Froggatt (1921, p. 812) has referred to its prevalence in New South Wales.

It is almost certain that more than one species is included under this name in Australia. The bronze-coloured forms so commonly met with are not necessarily specifically distinct from the bright-green individuals, as both may be found amongst the progeny of one female. The British Museum contains specimens with this specific designation from Melbourne, as well as from India, Egypt, South Africa, Great Britain, etc. One of the New Zealand sheep blowflies is identified as belonging to this European species.

LUCILIA SERICATA.

Periods.	January.	February.	March.	April.	May to September.	October.	November.	December.
Egg (hours) ..	16–17	16–17	16–17	18	24	20–22	16–23	16–22
Larval feeding (days)	4–5	4–5	4–5	5	5–6	5	4–6	4–5
Larval resting ..	3	2–5	2–7	3	5–22	4–5	3–5	3–5
Total larval ..	7–8	6–13	6–8	8–9	12–29	9–10	8–9	8–10
Pupal ..	7	6–8	6–8	7–8	11–17	7	7	6
Egg deposition to emergence of adult	13–16	12–16	14–16	15	26–28	15	12–13	12–16
Maturation ..	6–7	6–9	6–7	6–10	8–10	8	6–8	6–8
From emergence to oviposition	8–9	8–10	8–11	8–11	12	10	8–10	8–16
Adult longevity ..	25–35	12–25	12–36	28	20–29	..	15–35	15–36

In all tables in this paper the egg period is given in hours and the remaining periods in days unless otherwise indicated.

The egg period is generally between 16 and 17 hours in summer. The larval feeding stage usually occupies from 4 to 5 days except during winter when it takes 5 or 6; while the larval resting stage is generally 3 to 4 days in summer and

7 to 10 in winter. The pupal period is usually 7 days except during winter months when it may be twice as long. The time elapsing between the deposition of the egg and the emergence of the fly is generally about 13 days during summer, 15 days in spring and autumn, but considerably longer in winter. Generally about 8 days elapse between emergence of the adult and its subsequent oviposition. Longevity in captivity is usually about 20 days. Copulation may occur whilst on the wing and last only a few seconds or it may take place while the insects are resting and is then prolonged.

Froggatt (1913, pp. 25, 29) mentioned that in New South Wales eggs hatched out within a day (six hours in December) after having been laid ; that maggots were fully fed on meat in 6 or 7 days after hatching, pupating in the soil beneath ; and that flies emerged on the sixth day after commencement of pupation. The period from oviposition to emergence was thus about 12 or 13 days in summer, which corresponds with our observations in Brisbane during summer. In an earlier paper (1905, p. 17) he had stated that the larval stages occupied about a fortnight.

A series of observations regarding the pupating habit of this fly was published recently by us (J. & T. 1921, pp. 114-5 ; 1922, p. 130).

Bishopp and Laake (1915, p. 473) as a result of observations at Dallas, Eastern Texas, reported that hatching required from less than 24 hours to 7 days; the larval period 4 to 9 days in summer, but from 3 to 4 months during late autumn and winter ; the pupal period about 5 days in summer but from 24 days to 5 months in winter ; the total developmental period 11 to 15 days in summer increasing to from 4 to 6 months during late autumn and winter ; longevity of adults in captivity 10 to 40 days ; emergence to egg-laying 4 to 21 days.

Bishopp, Mitchell, and Parman (1917) recorded that *L. sericata* appeared during the warmer days of spring and persisted through the summer in U.S.A., where it took about as long to pass through its development as did the common black wool-maggot fly, *Phormia regina* Meigen, viz. about 11 to 15 days from egg to emergence of the adult fly.

In regard to a related fly, *Lucilia cæsar*, Herms (1915) stated that the egg period was from 6 to 48 hours ; the larval feeding stage 3 to 7 (generally 5) days ; the larval resting or prepupal stage usually 6 ; the pupal 8 to 34 (commonly 12) days ; the total number of days elapsing betw?n egg deposition and emergence of the adult fly being from 16 to over 60 days, generally 24 days; and the average longevity of the fly about 30 days. Pierce (1921, p. 132) mentioned that the larval period averaged 14 days and the pupal about the same length, but that in warm weather in Texas the larval stage occupied 3 to 12 days and the pupal 5 to 16 days while the total development (to emergence) required 11 to 24 days. Bishopp (1915, p. 323) stated that in Eastern Texas incubation required less than 24 hours in summer but up to 7 days in winter; the larval stage 3 to 9 days; pupal 3 to 13; egg to emergence of adult 9 to 21 days during comparatively warm weather; and that oviposition occurred in from 5 to 9 days after emergence.

Patton (1922A) mentioned that in India the eggs of *Lucilia serenissima* F. incubated in from 24 to 36 hours according to temperature.

Chrysomyia albiceps Wied.

This is the adult of the larger so-called hairy maggot and is one of the worst of the sheep blowflies in New South Wales and Queensland, where it is generally known as *Pycnosoma* or *Chrysomyia rufifacies*. It is most abundant in Brisbane during January and February, while in sheep districts of Central and Western Queensland it is especially in evidence during March, April, and May and may occur in numbers even in June.

Mr. Froggatt (1921, p. 811; 1920, p. 472) has lately used the name *Chrysomyia albiceps* Wied, as being its correct name, the determination having been made by Patton, who mentioned that it was a common Indian species. The latter author (1922C) has just published an account of the fly and its larval stages.

CHRYSOMYIA ALBICEPS.

Periods.	January.	February.	March.	April.	May to September.	October.	November.	December.
Egg (hours) ..	16	16–17	16	19	21	18	18	16–17
Larval feeding (days)	4–5	4–5	4–5	5	5–6	5	5	5
Larval resting ..	2–3	1½–2	2	2–3	4–10	..	2–5	2–3
Total larval ..	6–8	5½–7	6–8	6–8	10–15	7–?	7–10	7–8
Pupal	4–8	3–5	5–8	7–8	10–20	6	4½–5	4½–5
Deposition of egg to emergence of adult	10–13	9–13	11–16	13–17	20–36	13	12–16	12–14
Longevity of adult	2–29	10–30	..	..	26	23	6–29	16–30

The larva usually feeds for about five days, then follows a resting period generally occupying from 5 to 6 days during winter and 2 days in summer. The total larval period during midsummer (January to March) is usually 6 days, but 8 days during early summer, and longer during winter. The pupal period is usually from $4\frac{1}{2}$ to 5 days during the whole summer. No definite information is available as to the time which elapses between adult emergence and sexual maturity, and between emergence and oviposition, but about 5 or 6 days appear to elapse in the latter case (midsummer). Longevity in captivity during summer commonly ranged between 15 and 26 days.

Jarvis (1913, p. 11), who bred it in confinement at an average mean temperature of 75·5° F. (Longreach district, during October), stated that 7 days intervened between egg-laying and pupation—flies emerging 4 days later (i.e., a pupation period of 4 days). Hence the total period between deposition of eggs and the emergence of flies which developed from them was 11 days (Jarvis stated 12 though his dates indicate only 11).

The most rapid development from egg deposition to emergence noted by us occupied 9 to 10 days (February), 3 to 4 days of which were spent in the pupal condition (J. & T. 1921, pp. 112, 116). Illingworth (1918) referred to a similar rapid development of this fly in Hawaii (midsummer, July), where less than 4 days elapsed from the time of the deposition of the egg to the end of the larval feeding stage. He reported that the pupal condition occupied about 6 days, but this interval would include the time that we have indicated under larval resting stage, which would probably be 1 to 2 days. The total time from egg deposition to emergence was about $9\frac{1}{2}$ days, just as in the case noted by us. Froggatt (1913, p. 26) stated that less than a fortnight elapsed between these periods (New South Wales).

Patton (1922c, p. 563) states that the second, but more especially the third, stage larva of *C. albiceps* is entirely predaceous, feeding on the larvæ of other Calliphorinæ, as well as those of certain species of *Musca* in Mesopotamia and India, a character which it shares with *C. villeneuvii*. J. L. Froggatt (1919, p. 259) had already mentioned that the " hairy " larvæ of *Pycnosoma rufifacies* and *P. varipes* attacked and devoured the smooth-skinned maggots of other blowflies such as *Anestellorhina augur*, *Pollenia stygia*, and *Lucilia sericata*, while those of *Ophyra nigra* would attack all species.

Patton mentioned that the female lays her eggs amongst those of other Calliphorines; that the first instar lasts for about 36 hours, as in the case of *C. villeneuvii*, and the second from 2 to 3 days.

The biology of the related fly *Chrysomyia* (or better, *Cochliomyia*) *macellaria* Fabr., well known as the American screw-worm, which deposits its eggs in living domesticated animals as well as in man, but especially in cattle and sheep, has been worked out by various investigators. Bishopp, Mitchell, and Parman (1917) reported that eggs hatch in less than 4 hours, and when infesting living animals the larvæ are mature and drop from the wound in from 4 to 5 days, but when in carcasses they require 6 to 20 days unless the weather be hot and damp. The maggots burrow from 1 to 4 inches into the ground before pupating. The pupal stage lasts from 3 to 14 days, when the flies emerge and are soon ready (3 to 18 days) for egg-laying. The whole life-cycle is completed in from 1 to 4 weeks according to temperature and humidity. The adult fly lives only a short time—from 2 to 6 weeks. (*See also* Bishopp, 1915, p. 325-6.)

Herms (1915, p. 235) reported that the shortest period observed to elapse between the deposition of the egg or maggot to the emergence of the imago was 9 days, lengthening to 2 weeks or more under less favourable circumstances. Castellani and Chalmers (1919, p. 848) stated that the eggs hatched in from 1 to 9 hours, the larva matured in from 5 to 7 days, and the pupa in from 9 to 14 days. (*See also* Hall, 1921, p. 15.)

Chrysomyia (Microcalliphora) varipes Macquart.

This is the smaller hairy maggot-fly, commonly known as *Pycnosoma varipes*. Probably more than one species has been included in the previous accounts given under this name. Townsend in 1916 made it the type of his genus *Microcalliphora*. Though common during summer, this fly reaches its maximum development in Brisbane in February, during which month its life-cycle may be very much shortened, at times not more than 8 days elapsing between the deposition of the egg and the emergence of the resulting fly. The usual period during summer was found to be 10 or 11 days, increasing as winter approached, when over a month might be required.

MICROCALLIPHORA VARIPES.

Periods.	January.	February.	March.	April.	May to September.	October.	November.	December.
Egg (hours) ..	17	17	17–18	18	..	18	17–19	17–19
Larval feeding (days)	$2\frac{3}{4}$–$4\frac{1}{2}$	$2\frac{3}{4}$–5	4–5	4–5	5	$4\frac{1}{2}$–5	$4\frac{1}{2}$–5	$4\frac{1}{2}$–5
Larval resting ..	1–2	1–2	$1\frac{1}{2}$–2	2–3	3–8	..	$1\frac{1}{2}$–2	1–$1\frac{1}{2}$
Total larval ..	$4\frac{1}{4}$–6	5–7	$5\frac{1}{2}$–7	6–8	8–13	..	6–7	$5\frac{1}{2}$–6
Pupal	2–10	3–5	$4\frac{1}{2}$–5	5	8–21	..	$4\frac{1}{2}$–5	$4\frac{1}{2}$
Deposition of egg to emergence of adult	9–14	8–11	10–11	11–14	17–36	12–15	10–12	10–11
Longevity of adult	19–28	26–28	26	26–28	29	23–29	20–28	28–29

The larval feeding period generally occupied 3 days in January and $4\frac{1}{2}$ to 5 days for most of the year; while the larval resting period usually extended over 1 or 2 days in summer but 5 or 6 in winter. The pupal period commonly occupied 4 to $4\frac{1}{2}$ days in summer.

Chrysomyia megacephala Fabr.

This large, deep-blue blowfly is more commonly known in Queensland, the East Indies, and Hawaii as *C. dux* Esch. Van der Wulp in his "Catalogue of the described Diptera from S. E. Asia" (1896, p. 148) quotes the latter name with *Lucilia flaviceps* of Macquart and of Walker as a synonym.

Froggatt has referred to it frequently and figured it as *Lucilia tasmaniensis* (Brisbane, New Hebrides, and Solomon Islands), but recently (1921, p. 812) has recorded it as *C. flaviceps* apparently on the authority of W. S. Patton, who reports it as a common "bluebottle" blowfly of Eastern bazaars and as one which breeds readily in decaying animal matter.

It appears in Brisbane in great numbers during the summer but does not become the dominant species until about March. It occurs in Sydney but is not so abundant there. The British Museum contains specimens from the Northern Territory and many North Queensland localities.

Though it is readily attracted to decomposing animal matter we have not yet observed it ovipositing nor have we bred it out from carrion.

Patton (1922B), who recognised this fly as belonging to Fabricius' species, described the larval stages and mentioned that the larvæ hatch out in about 24 hours in India. Though various stages in the related Indian blowflies, *Chrysomyia bezziana* and *C. nigriceps*, have been described by Patton (Ind. Jour. Med. Res. 8 (1), 1920, pp. 17-29 ; 1922B), the times occupied by them are not mentioned.

Neopollenia stygia F.

The golden-haired blowfly, known also as *Calliphora villosa*, occurs very commonly during the winter months in Western Queensland. It becomes less abundant in September and diminishes in numbers as summer approaches, when it is seldom seen. Froggatt reports it as being prevalent in New South Wales sheep-country from September onwards well into the summer. He states that it is common throughout the year in Sydney.

We have not kept records of the developmental periods of this fly. Froggatt (1915, p. 20) states that the time required for the egg to develop into a fly in summer in New South Wales averages a fortnight.

Paracalliphora augur L.

This blowfly is known under a variety of names—*Calliphora oceaniæ*, *C. augur*, *Anestellorhina augur*, etc. The genus *Paracalliphora* was erected for it by Townsend (Canad. Entom. 48, 1916, p. 151).

The fly is quite common in Brisbane during the winter (May onwards), increasing as *N. stygia* begins to diminish, but it is not abundant in summer. It is capable of depositing either eggs or maggots and at times both may be deposited on the same occasion. Eggs usually hatch out in about six hours in Brisbane. The larval feeding period is about 4 days, while the resting stage occupies about 5 days except during winter when it is usually 6.

PARACALLIPHORA AUGUR.

Periods.	January.	February.	March.	April.	May to September.	October.	November.	December.
Larval feeding ..	4	..	..	..	5	4	4	4
Larval resting ..	..	..	..	..	5–8	4–6	5	4–5
Total larval ..	..	..	..	..	10–14	8–9	9	8–9
Pupal	..	..	..	10–14	10–19	13–14	13	13
Egg deposition to adult emergence	..	20	..	..	21–33	21	19–20	20

Froggatt (1915, p. 19) reported breeding the species from carrion all the year round though it was during winter that it infested sheep. He recorded that during winter the larvæ required 2 to 3 weeks to become fully fed while the pupal stage occupied a month to 6 weeks, so that from 6 weeks to 2 months were required under laboratory conditions, but that a fortnight or even a month longer was necessary under natural conditions. During summer, he stated, only 14 days intervene between the egg and the emergence of the adult fly, larvæ being fully fed on the seventh day.

In an earlier paper (1913A, p. 23) he mentioned that eggs laid in November gave rise to larvæ which pupated in 6 days and emerged 11 days later, the period from the egg to emergence of the fly being 14 to 15 days (his dates show a period of 17 days). During December, 18 days elapsed in a case recorded.

Calliphora erythrocephala Meigen.

This large, dark blowfly, an importation from Europe, is common in New Zealand and in Sydney. As we have seen only one specimen in Brisbane it must be very rare, though it may succeed in establishing itself. No data regarding its biology in Australia have been published.

Bishopp (1915, p. 327) mentioned that in Eastern Texas the incubation period was 24 hours; the larval feeding stage 3 or 4 days; the pupal stage 7 to 9 days; the period from egg deposition to emergence ranged from 15 to 20 days ; and that oviposition occurred in from 12 to 17 days after emergence.

Pierce (1921, p. 131) stated that the eggs required 10 to 24 hours to hatch ; the larva $7\frac{1}{2}$ to 8 days at 23° C. (73·5° Fahr.) ; and the pupa 14 days for development, though larvæ had been known to attain full development in from 3 to 4 days and the flies to emerge in from 15 to 20 days after the eggs had been deposited. (*See also* Hewitt, 1914.)

Sarcophaga spp.

Flesh-flies are to be met with in Brisbane throughout the year but are particularly plentiful during March and April. They are larviparous. The larval feeding stage occupies about 4 or 5 days during summer. The pupal stage is greatly prolonged during winter, some of our specimens taking from 8 to 16 weeks before emerging. Overwintering evidently takes place in the pupal condition. From 12 to 18 days elapse during summer between larviposition and the emergence of the adult. In 2 or 3 days after emergence copulation occurs.

Herms (1915, p. 238) states that under optimum conditions, presumably at Berkeley, California, *Sarcophaga sarraceniæ* Riley requires 5 days for its larval development and 13 for the pupal, a total of 18 days from larviposition to emergence.

Sarcophaga peregrina R. D.

Period (days).	Nov.–Dec.	Jan.–Feb.	March–April.	Winter.
Larval feeding	3–6	3–5	5–6	..
Larval resting	3	3	2–3	..
Total larval	6–9	6–8	7–9	..
Pupal	8	8–9	3 to 9 weeks	8 to16 weeks
Larviposition to emergence	14–17	14–17	20 days to 10 weeks	..
Emergence to copulation	2–3	2–3	2–6	2–8
Emergence to larviposition	11	11	11	12
Larviposition to larviposition	25–28	25–28	31 days to 11 weeks	..

Sarcophaga tryoni J. & T.

During the winter this large golden fly takes 7 days to pass through its larval feeding stage, 7 to 8 days for the larval resting or prepupal stage, and 7 weeks to complete its pupal stage.

Sarcophaga impatiens Walker.

Period (days).	Jan.–Feb.	Winter.	October.
Larval feeding	5–6	7	4
Larval resting	2–3	7–8	7–8
Total larval	7–9	14–15	11–12
Pupal	5–9	19 days to 10 weeks	5–6
Larviposition to emergence ..	12–18	33 days to 12 weeks	16–18
Emergence to copulation ..	2–3	2–3	2–3
Emergence to larviposition ..	11	10–12	11
Larviposition to larviposition ..	23–30	30 days to 14 weeks	28 ?

Sarcophaga omikron J. & T.

The pupal stage (bred from decaying potato) in the Upper Burnett district during January 1920 was about 13 days (*M. J. Bancroft*).

Ophyra nigra Wied.

This shining black Anthomyid blowfly is extremely common in Southern Queensland and in New South Wales, and is readily attracted to carrion, where it may be collected all the year round.

In Brisbane the eggs usually require 24 to 25 hours for hatching. The larva feeds for 5 or 6 days and then passes through a resting stage varying in length from 7 to 11 days in summer and from 3 to 4 weeks during winter. The pupal stage lasts for about 8 days in summer and 2 to 3 weeks in winter. The period elapsing between the deposition of the egg and the emergence of the resulting fly is about 20 days in midsummer, increasing to about 30 in autumn and spring, while during winter about 10 weeks are required. In about 5 days after emergence, copulation occurs, egg-laying taking place within 1 or 2 days. The fly lives for about a month in captivity.

OPHYRA NIGRA.

Periods.	January.	February.	March.	April.	May to September.	October.	November.	December.
Egg	24	24	24–27	25	27	..	25	25
Larval feeding ..	5–6	5–6	5–6	5–6	6–7	..	5½–6	5–6
Larval resting ..	10–11	10–11	7–8	15–25	20–30	11	9–11	6–7
Total larval ..	15–16	15–16	12–15	20–30	26–30	..	15	12–13
Pupal	8	8	8–9	9–12	13–25	8	6–8	7–8
Egg deposition to adult emergence	19–24	19–24	21–30	28–29	about 10 wks.	28	21	19
Maturation ..	4½–5	4½	5	5	..	..	5	5
Emergence to oviposition	5–6	5–7	6–7	6–7	..	..	6	5
Adult longevity ..	22–29	20–28	..	..	29	28	22–29	20–29

Stomoyxs calcitrans L.

We have not attempted to ascertain the length of the various stages in the life-cycle of the stable-fly. The time which elapsed between the deposition of eggs and the emergence of the adult fly from them in Brisbane was found to be from 14 to 19 days during January and February, 20 to 33 during April, 24 to 40 during winter (May to October), 20 to 21 during November and December. The usual time in S. E. Queensland seems to be about 20 days during summer, though less in midsummer, increasing to from 3 to 5 weeks during winter. Hill's data (1918) show that a total of 21 days elapsed in Melbourne during January and February.

Bishopp (1913, 1916, 1920) has investigated the biology of *S. calcitrans* in Dallas, Texas, U.S.A. During late autumn (Sept. and Oct. 1912) he found that the egg period ranged from 1 to 4 days; larval from 11 to over 30; pupal 6 to 20; the time elapsing from oviposition to emergence being from 19 to over 42 days (1913, p. 121-2). In a later paper (1916), he gave a more complete account and stated (p. 17) that on the average the last-named period generally ranged from 21 to 25 days when conditions were very favourable; that the longest period observed for complete development was 43 days, though it was certain that during late autumn and winter a much longer period (up to 3 months) was necessary in Northern Texas. Flies were found to live about 17 days (occasionally 29 days) in confinement when supplied with blood as food. Similar information was republished by him in 1920.

Herms (1915) reported that in the vicinity of San Francisco, California, at a temperature of 21° to 26° C. (70° to 80° Fahr.), the following periods were observed:—Egg stage 2 to 5 days, average 3 days; larval stage 14 to 26, usually 15 days; pupal stage 6 to 26, generally 10 days; time elapsing from oviposition to emergence 22 to 57 days, average 28 days. Copulation was found to occur within a week from emergence and egg deposition about 18 days after emergence, at the temperatures stated. The longevity of adults averaged 20 days, the maximum observed being 69 days.

Hewitt (1914, p. 200) reported that (in England, presumably) the egg required from 24 hours to 4 days to hatch; the larva 7 to 30 days for its development; and the pupa 5 to 20 days before emergence. The period from egg deposition to the emergence of adults varied from 13 days to 10 weeks. Flies were found to live from 72 to 94 days in captivity and to begin to oviposit on the 9th day after leaving the puparium.

Newstead (1906) found that in England, at a day temperature of 72° Fahr. and a night temperature of 65° Fahr., eggs hatched in 2 to 3 days [1]; the larval stages occupied 14 to 21 days (or even as much as 78 days when conditions were unfavourable); the pupa 9 to 13 days; while the period from egg deposition to emergence required from 25 to 37 days, but when conditions were drier and the larval stage as a consequence was lengthened, then the cycle occupied from 42 to 78 days. Howard (1912) and Hindle (1914) republished Newstead's figures. (*See also* Newstead, Dutton, and Todd, 1907, pp. 75-86.)

Mitzmain (1913), working in the Philippines at a warm temperature of 30-31° C. (86°-91° Fahr.), found that the larval life averaged 12 days, the pupal 5 days, while the maximum period for which flies lived in captivity was found to be 72 days in the case of a female and 94 for a male.

[1] Newstead (in Newstead, Dutton, and Todd, 1907, p. 87) states that at a temperature of 64-67° F. eggs did not hatch until the 8th day.

Patton and Cragg (1913, p. 366) reported that in India the egg hatched in 12 hours, the larva matured in from 7 to 21 days, and the pupa in about 4 days. Hence the total period from egg deposition to emergence occupied from about 11 to 25 days.

Lyperosia exigua Meijere.

The bionomics of the buffalo-fly (a relative of *Stomoxys*), in the Northern Territory, were briefly dealt with by Hill (1916). The egg stage occupied 18 to 20 hours; larval, i.e. from the hatching of the egg to the formation of the puparium, 72 to 96 hours; pupal stage 72 to 120 hours. The life-cycle (egg to emergence) was found under laboratory conditions, in the case of flies reared in March (late summer) to average 169 hours (7 days), ranging from 120 hours during warm sultry weather and 192 to 195 when the weather was rather cooler; while in the case of a fly reared in June when the weather was still cooler, 208 hours (nearly 9 days) elapsed. Patton and Cragg (1913, p. 376) state that in India the fly emerges in from 5 to 8 days from the time the eggs are deposited.

The biology of *Lyperosia* (or *Hæmatobia*) *irritans* L. in Europe has been studied by Wilhelmi (1921). Pierce (1921, p. 234) states that in U.S.A. this species, the hornfly, requires about 17 days from egg to adult.

Musca domestica L.

With the exception of a casual record by Johnston and Bancroft (1920), the only work published relating to the biology of the common housefly in Australia is that of Willis (1913), though Cleland (1913) has given information regarding the percentage of this species amongst the flies caught in houses in Sydney. Froggatt (1910, p. 246) referred to the stages of housefly development, but there is nothing to indicate that his periods relate to actual observations in Australia.

Except in a few cases, no attempt was made by us to determine the length of time passed by the fly in its various developmental stages. It was ascertained that in Eidsvold during November the egg required a day to hatch; the first instar was passed through in a day; the second in a similar period; the third in 3 or 4 days (making a total egg and larval period of 6 to 7 days); the pupal stage in 9 to 10 days; making a total of from 15 to 17 days from oviposition to emergence (Johnston and Bancroft, 1920, p. 5).

During November 1919 in Brisbane the combined egg and larval stages required from 5 to 7 days (generally 6), and the pupa from 8 to 10 (generally 9) days for development, so that the total period from egg deposition to adult emergence was from 14 to 16 days. This month was dry. During the succeeding January and February (1920) the periods were—Egg plus larval, 4 to 6 days; pupal, 4 to 8; the period between oviposition and emergence ranging from 8 to 12 days during these hot, moist months.

From later observations made by us in Brisbane (1920, 1921), it was ascertained that the housefly could pass through its stages from the egg to the imago in from 7 to 8 days during midsummer, but needed from 11 to 15 during autumn (April and May), and 12 to 16 during winter. Horse-manure was used as the pabulum in all our breeding work with houseflies. Copulation took place in from 4 to 8 days after emergence and oviposition occurred 4 days later.

Willis (1913), working in Sydney during November and December 1910, gave his minimal observation in the case of material incubated at 28-30° C. (82-86° F.), when a period of 12 days elapsed between the date when eggs were first seen and adults first emerged, while with a temperature maintained at 30-34° C. (86°-93° F.) it was not quite 10 days. He noted that pairing seemed to occur two days after emergence, and reported that oviposition took place six days after emergence, at the higher temperatures mentioned.

Hill (1918) reported that in Melbourne eggs hatched in from 12 to 24 hours, flies emerging during midsummer in about 14 days after eggs had been laid. Such flies mated in from 4 to 6 days after emergence and oviposition occurred about 4 days later. Midsummer in the Southern States of Australia is comparatively dry whereas in Brisbane it is normally moist (January to March).

Patton and Cragg (1913) reported that, in India, houseflies emerged about the 6th or 7th day after the eggs were laid; while Smith (1907) recorded that a period of 8 days elapsed when flies were bred from horse-manure at Benares, India. These abbreviated periods are comparable with those above recorded by us as observed during the moist midsummer of S. E. Queensland.

Hewitt (1914, p. 109) reported that the shortest periods observed by him during the summer in Manchester were—Egg, 8 hours ; first instar 24 hours, second 24 hours, third 3 days ; pupa 3 days ; total 8 days 4 hours,—but that probably not less than 9 days, and commonly 10 or more, elapsed under natural conditions. It should be mentioned, however, that Griffith (1908) obtained a minimum of 8 days (egg to pupa $4\frac{1}{2}$ to 6 days, pupa to fly $3\frac{1}{2}$ days) in the south of England. The minimum obtained by Newstead (1907) in Liverpool was 10 days, as also was that recorded by Packard, observed in Massachusetts, U.S.A. At an average daily temperature of 22·5° C. in England, flies require 14 to 20 days to emerge when eggs were laid and the larvæ developed in horse-manure (Hewitt).

The influence of moisture and temperature on the length of the various periods in fly development has been studied by Newstead (1907) and by Hewitt (1914). (*See also* Graham Smith, 1914, p. 42.) Egg period at 10° C. 2 to 3 days ; at 15-20° C. about 24 hours ; at 25-35° C. 8 to 12 hours. Larval period—first instar 20 to 36 hours or even to 4 days ; second instar 24 hours (25-30° C.) to several days ; third instar (including prepupal stage) 3 to 4 days (25-35° C.) ranging to 8 or 9 when conditions less suitable ; total larval period 5 to 8 days (when conditions of temperature and fermentation favourable) ranging to 8 weeks. Pupal period between 3 and 4 days (at 35° C.) ranging to several weeks. The temperatures mentioned (25-35° C.) approximately correspond with those in tropical climates and in subtropical regions (such as Brisbane) during midsummer, and the results obtained by Hewitt, using incubators, are similar to those recorded by Patton and Cragg and by Smith for Indian conditions, and by us for Eastern Queensland.

Howard and Hutchison (1915, 1917) gave the larval period (including egg stage) as 4 to 5 days under favourable conditions in U.S.A. ; pupal 3 to 10 days in midsummer (up to 5 months during midwinter) ; and mentioned that the shortest time recorded as elapsing between egg deposition and adult emergence in U.S.A. was 8 days, records of 10 to 12 days being common ; and that only 3 or 4 days were needed during midsummer for females to reach maturity after emergence.

This preoviposition period, as it has been named, has been carefully studied by Hutchison (1916), who attempted to represent graphically its relation to temperature. The time varied from $2\frac{1}{2}$ to 23 days, from 3 to 5 days being required when the temperature was in the vicinity of 80° F. (which corresponds with Brisbane summer).

Howard (1912) reported that in Washington D.C., during midsummer, larval life occupied 5 days (24 hours + 24 hours + 72 hours) and the pupal normally 5 days ; while Pierce (1921, p. 129) gave them as 4 and 3 to 10 respectively (U.S.A.).

Herms (1915) published maximum and minimum periods for egg, larval, and pupal stages as well as for total periods from egg to imago, based on observations in Berkeley, California. In regard to the last-named period he found it to vary from 12 to 18 days, usually from 14 to 18, but at a temperature maintained at 30° C. the minimum observed was $9\frac{1}{3}$ days. The average, minimum, and maximum lengths of time in days required between egg deposition and emergence at certain temperatures were found to be respectively as follows :—At 16° C.—44·8, 40·5, 48·6 ; at 18° C.—26·7, 23·1, 30·25 ; at 20° C.—20·5, 18·8, 22·25 ; at 25° C.—16·1, 14·5, 17·8 ; at 30° C.—10·4, 9·3, 11·5.

Stiles (1921) stated that larvæ matured in the shortest time in fermenting materials at a temperature of 90-98° F. (32·2°-36·7° C.) and that at higher temperatures (100-110° F.) they left the hotter portion of the manure in which they were feeding. At temperatures between 65° and 75° F. (18·3-23·9°C.) the "duration of life-round" was 3 weeks, presumably in the vicinity of Washington D.C.

Hewitt (1914) reported that flies reached sexual maturity in England in August and September in from 10 to 14 days after emergence, oviposition occurring 4 days later. Hutchison (1916) stated that copulation may occur on the first day after emergence, but usually took place between the 3rd and 6th days, provided the temperature was not below 55° F.

Austen (1920, p. 19) reported that, in June 1915 at Rouen during very hot weather, houseflies bred out in a little more than 6 days from eggs laid in horse-manure, while at Kantara, Suez Canal, in May 1916 during extremely hot weather, about $7\frac{1}{2}$ days elapsed, but that in England under very favourable circumstances 7 to 8 days were needed. To the latter period there must be added from 14 to 18 days before the emerging flies can lay eggs ; hence in the British Isles during very hot weather about 3 weeks would be sufficient to elapse between egg deposition by a fly and oviposition by the progeny of such fly (p. 16). Howard and Hutchison (1915, 1917) showed that in Washington D.C. such would be possible in from 11 to 14 days during midsummer. We do not know the minimum preoviposition period in Brisbane, but, as our climatic conditions during summer are somewhat similar to those in which Hutchison obtained his minimum results, it is likely that in the coastal districts of Queensland during midsummer (say January to March) a period of from 9 to 11 days may represent the minimum period between egg deposition by a fly and by its progeny.

We have no information regarding the length of time houseflies can live in captivity in Australia, but Austen (1920) mentioned 7 to 16 weeks in England; while Howard and Hutchison (1915) recorded periods of 30 days during winter (New Orleans), 35 to 40 days at temperatures of 65-75° F. (Virginia), one of 70 days at a temperature ranging from 32° to 50° F. (Virginia), and (1917) one of 91 days (44-57° F.). Hutchison (1916) recorded a longevity varying from 1 to 54 days (average of 3,000 records being 19½ days) during summer and autumn (U.S.A.). On account of the much warmer climate of Australia, such long life-periods are unlikely to occur here normally.

Bishopp, Dove, and Parman (1915), working at Dallas and Uvalde, Texas, found that eggs hatched in less than 24 hours even in winter: the larval stages required from 3½ days to about 3 weeks, usually 4 to 7 days during warm weather; pupal stage 3 to 26 days, ranging to more than 2 months during winter; time from egg to emergence 8 to 11 days (midsummer) increasing to 25 to 51 (midwinter); and in one case the combined larval and pupal stages occupied 6 months (November to May). Copulation was observed to occur from 1 to 16 days after emergence. Oviposition took place in from 4 to 20 days after emergence—usually 4 to 9 days in summer and 10 or more in autumn. Longevity in captivity was found to be from 2 to 53 days—generally 2 to 4 weeks during summer when food was sufficient.

Musca vetustissima Walker.

This is the common, small, dark, bush fly of Australia and has been referred to in literature under a variety of names. Coquillet determined it for Froggatt (1905) as *Musca corvina* Fabr. (a European fly now known as *M. autumnalis* Geer.), and it is under such name that the latter author has figured it and written of it in his various papers excepting in a recent article (1921) where he calls it *Eumusca australis,* though it has been shown that the latter specific name belongs to a quite distinct fly (Johnston and Bancroft 1920A, 1920C). It has also been referred to as *Eumusca vetustissima,* as it falls within Townsend's genus if the latter is recognised as valid (Johnston and Bancroft 1920C, Johnston 1921B).

Bezzi determined it for G. F. Hill as *Musca humilis* Wied., an Indian fly, and it is under this name that Hill mentioned it recently (1921). Dr. Patton, in a letter to the senior author dated August 1921, stated that Walker's species was a synonym of Wiedemann's, but in a letter a few months later (Dec. 1921) he said that *M. vetustissima* was certainly not *M. humilis,* but was Macquart's *M. pumila.* Our bush fly is certainly very much like the figure of *M. humilis* given by Patton in Indian Journal of Medical Research, 7, (4), plate 68[2] (For further references to *M. humilis see* Patton, l.c. 8 (1), 1920, pp. 1-16; Rev. Appl. Ent. B. 9 (6), p. 102.) In view of the above contradictory statements we prefer to retain Walker's name until some authoritative pronouncement shall have been made.

The biology of the fly under the climatic conditions occurring in Brisbane and in Eidsvold (Upper Burnett River district) has been made known by Johnston and Bancroft. The time passed in the egg stage and in the various instars and pupa has been ascertained, the egg and larval stages usually requiring 4 to 5 days and the pupal about 6 in summer, whereas in spring and winter the latter may need 7 to 9 days. The total period from egg to imago was found to be from 10 to 14 days in Eidsvold during November when the weather was rather dry. (Johnston and Bancroft 1920A; 1920C, pp. 35, 41; Johnston 1921B.)

Other observations during October, November, and December confirm the above results, the egg hatching out in less than 24 hours; the combined egg-plus-larval period being from 4 to 6 days, generally 5; the pupal period 6 to 10, usually 6 or 7 days; the total period from egg deposition to emergence being 11 to 13 days. No doubt all stages would

[2] The life history and breeding habits of *M. determinata* and *M. humilis* are described in the paper, pages 754-5, 757-8.

be abbreviated during the moister summer months (January to March or April), but we have no records for that part of the year.

Awati (1920), in dealing with the biology of certain Indian species of *Musca*, stated that *M. promiscua* (a species with thoracic stripes somewhat like those of *M. vetustissima*) passed through its stages from the egg to the sexually mature imago in 9 to 10 days (egg less than one day; larva 1; pupa 4; adult 4 days before maturity was reached), eggs being laid from 4 to 10 days after copulation. The time elapsing between egg deposition by a fly and by its progeny from such eggs (i.e. from egg stage to egg stage) was found to be from 19 to 28 days. The longevity varied from 42 to 56 in the different species of *Musca* under observation.

Musca fergusoni Johnston and Bancroft.

This is much more robust than the last-mentioned species and has four well-defined thoracic stripes. It has received several names. Macquart described it as *M. australis*, but the name was already preoccupied by Boisduval. Hill (1921) quoted these names as synonyms of *M. lusoria* Wied., an Indian fly, the determination having been made by Bezzi. Johnston and Bancroft transferred the species to *Viviparomusca* Townsend (Johnston and Bancroft 1920C; Johnston 1921B).

Dr. Patton in a letter dated August 1921 stated that the species belonged to the *lusoria-bezzii* group, but in a later note (Dec. 1921) informed us that it was *M. convexifrons* Thomson (*nec* Bezzi). Its similarity to *M. bezzi* Patton and Cragg was pointed out in the original account (J. and B. 1920A). Until the synonymy is definitely established we think it preferable to use the above name.

The various stages in the life-cycle and the periods of time occupied have been dealt with (J. and B. 1920A; Johnston 1921B). The fly is practically larviparous, as a larva in the second instar escapes from the thin eggshell immediately the egg is deposited by the female. Pupation occurs on the 3rd day, the larval stages requiring 2 or a little over 2 days during summer, but 4 in October and up to 6 in winter. The pupal stage required from 9 to 15 days in summer and 27 to 32 days in winter (Eidsvold).

The fly has been found breeding throughout the year in the Brisbane district, but generally only a few pupæ of the species can be collected even from considerable quantities of cow-manure during winter. The pupæ are to be found in the manure close to the surface. The species occurred most commonly during March and April.

Additional observations during 1919 and 1920 regarding the life-cycle may be mentioned—(*a*) days in larval stage, (*b*) length of pupal stage, (*c*) total time elapsing between larviposition and emergence :—

——	(*a*) Larva.	(*b*) Pupa.	(*c*) Total.
January	2	7–8	9–10
February	2	7–8	9–10
March	2–3	7–12	9–14
April	3– ?	13–15	16–18
May	5–6	?–26–32	19–38
June	7–8	26– ?	33–40
July to September	7–8	27–39	34– ? 47
October	4	11–12	15–16
November	3	8–9	10–12
December	2–3	8	10–11

The total cycle in Brisbane apparently requires about 10 days for its completion during summer, and over a month during winter. The pupal stage occupies about 8 days during summer but about 4 weeks during winter, though our longest record was 39 days. There is a marked lengthening of the larval period during winter months. Flies kept in captivity during winter lived for periods varying from 10 to 31 days, usually about 24 days.

Musca terræ-reginæ Jnstn. and Bancroft.

The biology of this rather uncommon fly has been studied by Johnston and Bancroft (1920A, pp. 34, 35; Johnston, 1921B), whose observations were made chiefly at Eidsvold, Upper Burnett River, the results obtained being practically the same as those ascertained in the case of *Musca domestica* when under similar conditions (egg less than 24 hours ; first instar 24 hours, second 24 to 48 hours, third 2 to 3 days, total larval 5 to 7 days ; pupal 7 to 10 days ; total from egg to emergence 12 to 17—while the total in the case of the housefly during the same month, November, was from 15 to 17 days).

Additional data :—

—	Larval.	Pupal.	Egg to Emergence.
November	5–9	7–11	13–18
December	5–7	5–8	10–14
January	4–5	6	10–11

Musca hilli Jnstn. and Bancroft.

This is also a rather uncommon fly. Observations regarding its biology have been made by Johnston and Bancroft (1920A, p. 38 ; Johnston 1921B), working at Eidsvold and in Brisbane during midsummer, the periods being found to be similar to those of the housefly under similar conditions (larva 5 to 6 days ; pupa 6 to 9 ; total 11 to 15 days). In another paper (J. and B. 1920B, p. 74) they refer to a total period of from 8 to 10 days from egg to emergence in Brisbane during midsummer.

Observations show that the larval period in Brisbane during midsummer ranges from 4 to 6 days (generally 5 or 6) ; the pupal 5 to 8 (usually 6 days) ; and the total period between egg deposition and emergence from 10 to 14 (usually 11 to 12) days.

Hill (1921) refers to this species as a synonym of *M. nebulo* F., a common Indian fly, his information having been derived from Prof. Bezzi. Major Patton in a letter (August 1921) to the senior author stated that *M. hilli* was *M. ventrosa* Wied., but in a later letter he reserved judgment. But Hill (1921) recorded certain specimens from North Queensland as *M. ventrosa* Wied. (syn. *M. nigrithorax* Stein)—Bezzi's determinations,—but this refers to a different fly. We prefer to retain the above name until the synonymy shall have been settled.

Awati (1920) did not fix *M. nebulo* on account of its scanty original description, and in dealing with the biology of one of the Indian flies with a four-striped thorax, *M. divaricata*, he added (? *nebulo*). In regard to this fly he stated that the egg required about a day, the larva a day, and the pupa 4 to 6 days—thus 6 to 8 days from egg to emergence; while 4 to 8 days were required for maturity, giving a total of 10 to 16 days. Egg-laying occurred 4 to 10 days afterwards, the period elapsing between the time of oviposition of a fly and that of its offspring arising from such oviposition (i.e. from egg to egg) being from 19 to 28 days.

Pyrellia proerna Walker.

This handsome greenish-blue fly, which in Brisbane so commonly frequents cowdung for food and for the purpose of oviposition, has been referred to in earlier papers by Johnston and Bancroft as *Lasiopyrellia* sp. (1920A, p. 182) and *Pseudopyrellia* sp. (1920B, p. 74; 1029C, p. 42). The species occurs in North Queensland also. The flies commonly become a deep blue after having been dead a few days.

Specimens taken by the senior author to the National Museum, Washington D.C., and to the British Museum, were determined by Dr. Aldrich as *Pseudorthellia viridiceps* Macq. and by Major Austen as *Pyrellia proerna* Walker, respectively. The material was compared by Austen with Walker's type (a female—locality unknown) in the British Museum, and as Walker's name *Musca proerna* (List Dipt. Brit. Mus. 4, 1849, p. 888) has a slight priority over Macquart's *Lucilia viridiceps* (Dipt. Exot. Suppl. 4, 1850, p. 249) Walker's name is here used. Townsend made Macquart's species the type of his genus *Pseudorthellia*, hence if this prove to be valid the correct name will be *Pseudorthellia proerna* (Walker). Dr. Aldrich stated that *Pyrellia viridifrons* Macq. was probably a synonym.

Though we collected all the stages of this fly, we did not keep records of the periods beyond noting that during May and June the pupal condition lasted for 18 days.

Johnston and Bancroft (1920B, p. 74) have shown that under experimental conditions the fly readily breeds in horse-dung and can become an intermediate host of the two nematodes, *Habronema musca* and *H. megastoma*.

ADDENDUM.

While this paper was in the press, three recent papers by W. S. Patton relating to the subject have reached Australia :—(1) " Notes on the Species of the Genus *Musca* " (Bull. Ent. Res., 12 (4), 1922, pp. 411-426) ; (2) " Some Notes on Indian Calliphorinæ, No. 6 " (Ind Jour. Med. Res., 9, 1922, pp. 635-653) ; (3) " Somes Notes on Indian Calliphorinæ, No. 7." (l.c., pp. 654-657).

In the first paper there are changes in the names of the Indian flies referred to in our paper. *M. determinata* Wlk. is a synonym of *M. nebulo* ; *M. determinata* Awati is *M. domestica* (atypical) ; while *M promiscua* Awati is *M. humilis* Wied. The following information is given relating to Australian species :—*M. vetustissima* Wlk., *M. minor* Mcq., and *M. humilis* Stein (nec. Wied.) are quoted as synonyms of *M. pumila* Mcq.; *M. fergusoni* J. & B. as a synonym of *M. convexifrons* Thomson ; while *M. hilli* J. & B. is probably identical with *M. ventrosa* Wied.

In the second paper information is published regarding the adults and larvæ of various blowflies, including *Chrysomyia albiceps* and *C. megacephala.*

In tne third paper data are published regarding the biology of another Indian blowfly *C. bezziana*, and reference is made to various Australian sheep-maggot flies, more particularly to the predaceous habits of the third laval stage of *C. albiceps.*

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Some Geological Features of Northern Australia.

By Dr. H. I. Jensen.

(Read before The Royal Society of Queensland, 31st May, 1922).

INTRODUCTORY.

Geological investigation has afforded abundant evidence that Eastern Australia differs markedly from Central and Western Australia in structural characters. Thus two of the distinctive features of the east coast as compared with the centre west are the persistence of folding right up into the Tertiary period, and the abundance of alkaline lavas in the former geological province.*

Suess,† following Clarke, calls the mountain range along the east coast the Australian Cordillera, and regards it as homogeneous. The distinctions between the range country of the Cordillera and the inland regions are obvious and undisputed. It is, however, very doubtful if the homogeneity of the Cordillera extends any further north than the Tropic of Capricorn. Indeed; geological unity seems to cease at Springsure and Yeppoon at the north end, and at Cape Howe at the south end.

The South-Eastern Massif.—Tasmania, Victoria, and the Monaro district of New South Wales constitute a geological unit, characterised by intense folding movements in the Palæozoic period, and by continued elevation and absence of

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* "The Alkaline Rocks of Eastern Australia," H. I. Jensen, Proc Linn. Soc. of N.S.W., 1908.

† "Das Antlitz der Erde," Suess.

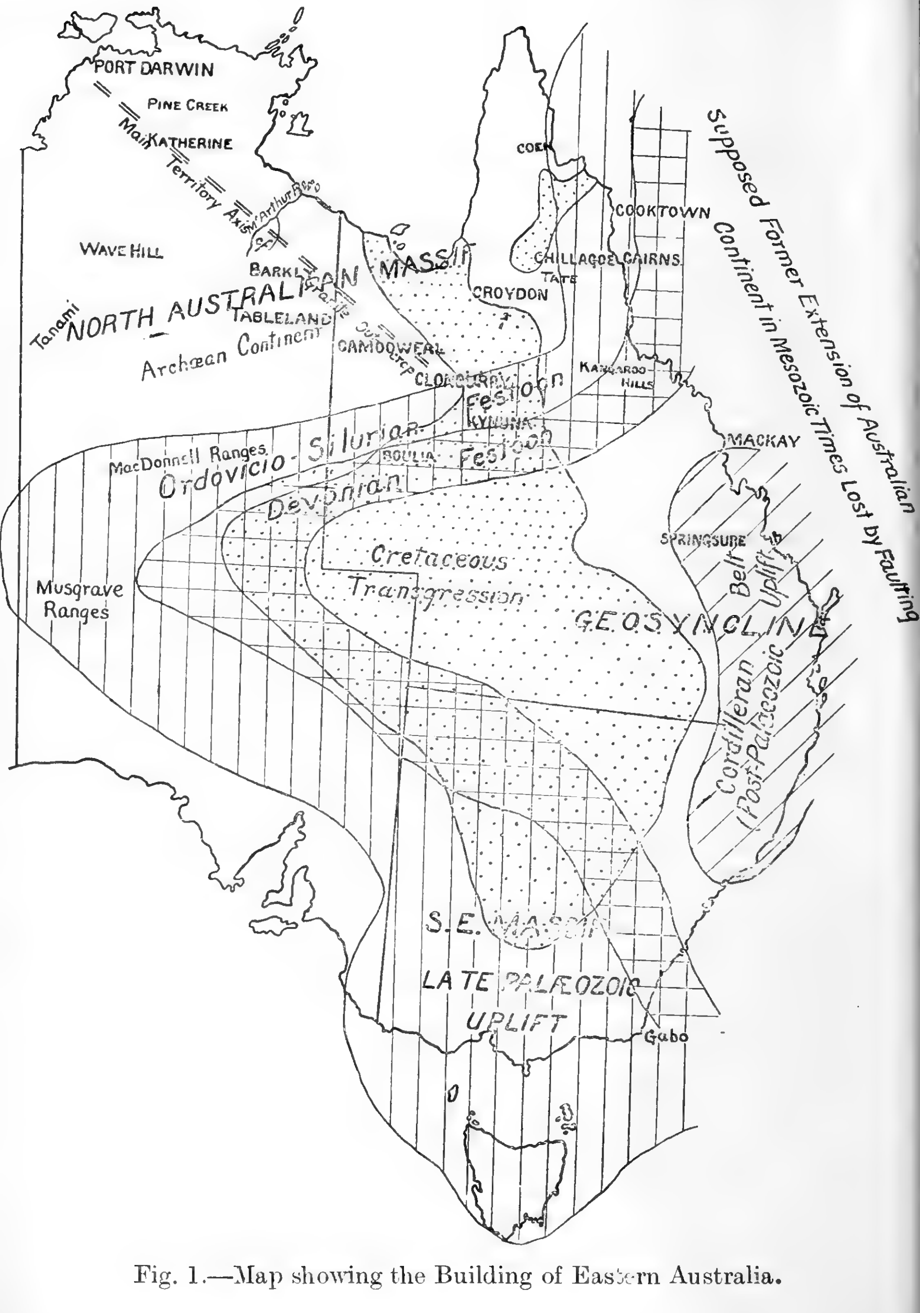

Fig. 1.—Map showing the Building of Eastern Australia.

folding since the Triassic, from which period on, plateau movement, combined with faulting and Senkungfeld formation, has been the dominant force.

The Cordillera.—The rest of Eastern New South Wales and Eastern Queensland to the Tropic of Capricorn form a geological unit characterised by a protraction of fold movements into later geological periods. In the northern portion of this unit even Tertiary beds are folded. The Triassic and Jurassic rocks are strongly folded in the Ipswich and Bundamba Coal Measures, and the Upper Cretaceous in the Styx basin. The area was also intruded by mixed lavas, of which the alkaline form an important portion, in the Tertiary period.

North Queensland is a region which is composed of a north-western massif (the Queensland portion of which might be styled the Carpentaria massif) and festoons of later formations folded upon that massif. In the Carpentaria massif fold movements ceased in early Palæozoic times, as was the case in the Northern Territory and Central West Australia, which are but an extension of the same massif. Even Cambrian rocks in the Northern Territory are but slightly folded. The eastern fringe of Carpentaria massif extends from Cape York and Princess Charlotte Bay south and south-west to Georgetown, thence south-west to Cloncurry and Camooweal. The massif is surrounded by a zone in which the Silurian and Devonian rocks are folded, but wherein the Carboniferous rocks are untouched by compressional forces. Outside this zone we have a festoon in which folding movements were protracted into the Carboniferous periods. The folded Silurian zone with sub-horizontal Carboniferous and Permo-Carboniferous outliers extends from the Cooktown mineral field through the Chillagoe field to the Charters Towers field. and thence under the Cretaceous (at Hughenden) to the district south of Cloncurry (Kynuna-Selwyn), and thence to the McDonnell Ranges in the Northern Territory. The folded Devonian belt extends from Maytown south-south-east to Mareeba ; and thence as the Burdekin Series, forming the next festoon it extends west-south-west from Kangaroo Hills towards Boulia, but is largely hidden by the Cretaceous. It recurs in the Arltunga area of Central Australia. Thus the north-central massif is surrounded by successive festoons in which folding was protracted into later and later periods, which extended the area of continental movement (plateau movement) in a south-east direction.* A similar feature is noticeable in the southern portion of the Cordilleran belt, where the area of plateau movement was extended from the south-eastern massif north to embrace the South Coast and Sydney districts prior to the deposition of the Hawkesbury sandstones.

The true geosynclinal portion of the Cordillera extends, therefore, roughly from Port Stevens to Mackay.

The true north-western massif (omitting the post-Cambrian additions), including the Territory and West Australian portions, has been an area of vertical movements only since the Cambrian period. Consequently the fissures formed by Archæozoic fracturing, which often constitute important ore channels, are of large size and great continuity, and have not been cut up, pinched out, partly obliterated and squeezed into discontinuous lenses, as has been the case in the regions which have undergone great Carboniferous and Mesozoic earth-fold movements. Thus, as far as Queensland is concerned, the continuity of lode formations and the value of our ore deposits increases from the Dawes Range northwards.

Alternation of uplift and depression, the repetition of plateau uplifts, may also have caused several zones of enrichment in the lodes of the massif areas. It would not be surprising here to find a second carbonate and oxide zone below the sulphide zone (which is not necessarily primary in all cases) in many lodes which have now been abandoned. Such a zone was found at a depth of 500 feet in the Girofla Mine, Mungana.

General mining experience has proved that the auriferous reefs of the East Australian Cordilleran region are principally quartz lodes locally enriched where they intersect carbonaceous beds, hornblende-andesites, or other rocks which favour gold deposition from magmatic solution.

In the northern massif, however, the lodes comprise both large fissures infilled with quartz, pyrites and sulphide ore, and large shear zones consisting of a ferruginous matrix carrying pay ores, and passing into sulphides below water level. An abundance of graphite is a feature of these great shear zones. In the sulphide levels graphite and pyrites are constant associates, and bear a definite relation to one another.

* Details of this zoning are given in a Queensland Geological Survey Bulletin prepared by the writer in 1919 but not yet published.

Quartz is of two ages—an older blue quartz and a later white quartz—as McLaren has shown for West Australia, in his work on "Gold," and the blue quartz which is sheared, is generally the richer. This blue quartz usually occurs in basic rocks and may be platiniferous.

McLaren's magnetite-hematite-quartz rocks, considered by him as derived from ferruginous sediments, occur abundantly in the massif, both in Queensland and the Territory, and are here regarded as shear zone formations. Without disputing the possibility of a derivation from sediments, the writer ventures to say that the re-arrangement and crystallisation of the constituents has been aided by movement on the bedding plane and by the introduction of mineralisers along the shear.

II. THE SOUTH-EASTERN OR KOSCIUSKO MASSIF.

Victoria, Tasmania and the Monaro district of New South Wales form a geological unit which has been an area of plateau uplift since the cessation of Permo-Carboniferous folding and mountain-building. Erosion to base level has taken place on several occasions, followed by renewed uplift and more or less faulting.

Each reduction of the plateau to base level has been followed by marine transgressions, of which the geological record of the Tertiary submergence alone has been preserved to a considerable extent. Thus in North-Eastern Tasmania, Southern and Western Victoria, and in the Riverina district of New South Wales, Kainozoic formations are frequent.

The faulting accompanying the great Mesozoic uplift was followed by the extension of the great diabasic sheets of Tasmania; and the Tertiary faulting, which produced Bass Strait, was followed by the basaltic eruptions of Central Victoria.

The principal alkaline effusions diagnosed in the south-eastern massif were those of Mount Macedon in Victoria, Regatta Point in Tasmania, and the nepheline phonolite dykes of Mount Kosciusko.

An interesting feature of this massif is the fact that while the general direction of the highlands is east and west, the fold direction is north-south. The Cordillera in Victoria is formed by the fusion of a number of north-south ranges, probably through a general plateau uplift along an east-west axis.

III. THE CORDILLERAN BELT.

This area might be described as extending from Cape Howe and Mount Kosciusko on the south, to the vicinity of Mackay in the north. Although comprising many stratigraphical formations, the region is a geological unit in that the direction of folding is identical with the direction of mountain axes and maximum elevation.

Through this belt the earth movements have been of a compressional type, true fold movements of the mountain-building nature. right up to the Tertiary period, though in the southern portion of the belt, the Hawkesbury sandstone of the Shoalhaven and Sydney districts, is not greatly disturbed. Further north, in the Clarence and Ipswich districts, considerable fold movements were experienced after Jurassic sedimentation, and in the Ipswich and Burrum districts even Tertiary beds show some folding. The Mesozoic formations are, however, dipping at very steep angles along a line from Ipswich north-north-west towards Mount Brisbane, and bent into an anticlinal fold in the D'Aguilar Range. Considerable rolls are observed in the same beds in the Moreton Bay district. When we get further north to the Maryborough district we find the still higher Upper Cretaceous rocks sharply folded. This is also the case with the Styx River Cretaceo-Tertiary Coal Measures, north of Rockhampton. The Bundamba and Walloon formations are folded into a very sharp anticline between Beaudesert and Boonah.

All these fold movements are but repetitions of the same impulses which gave origin to the belt of coastal elevation.

Alkaline lavas also characterise parts of this belt at Gib Rock, Mittagong, Mount Barrigan, the Warrumbungle and Nandewar Mountains, the Canobolas, and the subalkaline eruptions of Prospect and Kiama, all in New South Wales. Also the volcanic rocks of south-eastern Queensland, including those of the McPherson Range, the Springbrook Plateau, the Main Range, Mount Flinders and the Fassifern Peaks, the Esk hills, the Glass House Mountains, the Yandina and Cooran heights, and, further north, the Yeppoon Ranges and the Springsure district volcanics. The alkaline eruptions were in some cases followed by basaltic flows.* Trachyte tuff has been recorded by Maitland as far north as Mackay.

These eruptions belong typically to the western margin of the Cordilleran belt, though some of the groups are quite within the area of late folding, in which cases their existence is supposed to be indicative of trough faulting.

In South-eastern Queensland the Carboniferous and Permo-Carboniferous have been intensely folded, plicated, and altered. Strata assigned to those periods have been changed in the Stanthorpe-Texas district to hornfels, in Gympie to highly metamorphic slates and schists. This intense alteration, which is not noticed in the higher Jurassic strata, is in part due to the effect of the granitic intrusions in the early Mesozoic period. In New Guinea, where folding in Tertiary time was accompanied by Tertiary granitic intrusions, Kainozoic rocks are transmuted to an equal extent.

North Queensland.—North of the Tropic of Capricorn we find that the folding of the rocks corresponds with a series of plications forming arches, or festoons, round the Archean massif of the Northern Territory and North Queensland. The Gulf of Carpentaria regions are, in the writer's opinion, a part of the great north-central massif of the Territory and West Australia.

From the Sellheim gold and mineral field on the Suttor River, north and north-westwards to Mungana, the Tate and Georgetown, we have a region in which approximately east-west strikes predominate over those meridional or nearly so. It is an area in which the direction of folding has been east-west. Within this area occasional north-south folds are found as far north as Cooktown, secondary plications to the principal north-south axis now faulted beneath the sea, and possibly to some extent coincident with the Barrier Reef. The principal north-south axes within the area are the Cairns-Mareeba district (strike north-north-west) and the Kidston-Einasleigh district (strike north-south). The great majority of the strikes

* See "The Alkaline Rocks of Eastern Australia," by H. I. Jensen, Proc. Linn. Soc., N.S.W., 1908, and "The Volcanic Rocks of South-Eastern Queensland," by H. C. Richards, D.Sc., Proc. Roy. Soc. of Queensland, vol. xxvii, No. 7 (1916).

recorded in the aera are, however, more nearly east-west. Thus on the authority of Cameron (Q.G.S. Pubs. 151 and 219) the general strike in the region of Cave Creek, the Little Robertson, Western Creek, Georgetown, and McDonneltown, is east-west. At Mount Madden, Palmer Goldfield, east-west strikes, and in the Maytown to Limestone Creek belt north-west strikes, predominate (Jack, Q.G.S. Pub. 46). In the Cooktown tin area north-west strikes are also common. In the Irvinebank district the general strike is north-east (Skertchley, Q.G.S. Pub. 119), and in the Duff's Creek and Tate districts east-west (same author).

In the Ravenswood district the general strike is north-north-east (McLaren); and in the Cape River district west-north-west (Rands). The general strike in the Kangaroo Hills mineral field is east-north-east and east-west; and in the Cloncurry district east-west, west-south-west, east-south-east (Jack, and Rands, Q.G.S. Pub. 10, 104, 136, 153, &c.).

The west-north-west strikes are particularly noticed in schists and gneisses of great geological antiquity. This is the general strike direction also in the Precambrian formations of the Northern Territory, and the tectonic trend of the great granite intrusions which metamorphosed the schists of Northern Australia.

In greywackes and slates of Ordovician, Siluro-Devonian, and Devonian age the strike directions are more variable, while the Carboniferous and Permo-Carboniferous beds have been typically moulded on the Cambrian massif, and consequently strike in directions parallel with the outline of the massif.

The massif itself comprises, in addition to the bulk of Western Australia and the whole of the Territory north of the McDonnell Ranges, the Cloncurry-Burketown area, the Croydon Georgetown area, and the Cape York Peninsula west of a line running approximately from Fossilbrook to Princess Charlotte Bay. It is largely covered by Cretaceo-Tertiary deposits.

From Cooktown south along the coast to Kangaroo Hills, thence in a general west-south-west direction, through the Woolgar field to the Selwyn Range and probably on to the McDonnell Ranges, we have a festoon of Siluro-Devonian (?) rocks hidden here and there by the Cretaceous and Tertiary transgressions.

Figure 2

For further reference use Geological Map of Australia by Cotton and others (H. C. Robinson), Geological Map of Queensland (Q. Min. Index), Geological Map of the Northern Territory (*see* N.T. Bulletin No. 14).

Within the Northern Territory, on the massif itself, rocks later than Cambrian show little sign of folding. Even the Cambrian deposits in the Territory are often quite undisturbed (*see* "Northern Territory Bulletin" 14).

A Cambrian transgression formed limestones over a large area from Hall's Creek in Western Australia to Camooweal in Queensland. The fossils *Olenellus Hardmanni* and *Salterella Forresti* are indicative of the age of the horizon. A later Permo-Carboniferous inroad of the sea covered most of this area with shales and sandstones. Mr. H. Y. L. Brown has satisfactorily established the age of these beds by the help of fossils obtained at Anson Bay, Port Keats, and Borroloola. A Cretaco-Tertiary transgression or a series of oscillations in the late Cretaceous and early Tertiary period led to the formation of porcellanitic sandstones in numerous places, chiefly in the coastal belt, with fossil remains of belemnites, ammonites, gastropods, crayfish, &c. How far inland these late transgressions extended is not clear, owing to the horizontality of the Permo-Carboniferous rocks. The table sandstones of the interior have been regarded by Tenison-Woods as Desert Sandstone, but until some palæontological evidence can be found I think it is safer to regard them as Permo-Carboniferous.

The large area of Devonian rocks—the Burdekin series—which we see west of Townsville, probably occurs under the Basalts and Cretaceous beds from Lyndhurst to Boulia, and should be picked up between Urandangi and Boulia, from which region they most likely extend to the McDonnell Ranges, though covered at intervals by Cretaceous and Tertiary beds. In this belt the rocks overlying the Devonian would not be greatly folded.

From the Eungella goldfield, *via* the Sellheim field, westward through the Cape River district, until the series disappears under the Cretaceous, we have a festoon in which folding succeeded Permian sedimentation.

Thus as we proceed from Georgetown south-east towards Mackay, folding becomes progressively more recent, and when one gets south of latitude 21 deg. south, the rocks assume more and more the axial direction of the Cordilleran belt.

Movements in the Cambrian massif have been entirely of the plateau type, consisting of uplifts followed by long periods of erosion and peneplanation. The earth fissures formed in the pre-Cambrian and Cambrian movements have not been obliterated by later folding. The problems to be studied in their connection are chemical—those of leaching, secondary enrichment, &c.

Plateau Uplifts in General.—Plateau topography is typical of most of the tropical regions of the earth. Thus the Saharan portion of Africa, the whole of Arabia, the Deccan in India, Northern South America (Venezuela, Columbia, and Guiana) and Northern Australia, geologically studied, are plateau regions. Most of the adjacent seas are Senkungsfelder. Perhaps the earth's rotation on its axis has something to do with this condition. In these regions (tropical regions) the trend lines, or axial directions, of mountain ranges are predominantly west-north-west in the southern hemisphere, and west-south-west in the northern hemisphere, a feature which is even more noticeable in comparing Palæozoic strike directions than in the study of Cordilleran axes. It is also significant that in temperate zones the main axial directions are north-west in the southern and north-east in the northern hemisphere.

The data obtainable so far are somewhat crude and have never been systematically collected with a view of pursuing this study, but the facts known to us point to a plasticity of the earth's crust in the Archean period, which caused the sub-crustal igneous magmas to take on directions analogous to the trade winds. If further studies can elicit more facts in confirmation of this rule, the planetesial hypothesis can be definitely abandoned and the Lamarckian theory of the earth's origin can be regarded as definitely proved.

Blue and White Quartz.—In McLaren's "Gold" (The Mining Journal, London) it is emphasised that the auriferous Archæan terranes of Western Australia, Deccan, and South Africa, are characterised by two kinds of quartz—an older blue quartz and a later white quartz. This characteristic has also been noticed in the pre-Cambrian of the Northern Territory. The hornblendites and amphibolites which antedate the granitic intrusions (*see* N. T. Bulletin No. 16, pp. 47 and 48) are frequently traversed by veins of this blue quartz. Definite evidence of the relative ages of the amphibolites and granites was obtained by the writer in the Margaret and Pine Creek districts (*see* N. T. Bulletin No. 16). The blue auriferous quartz occurring in the hornblendites has been sheared ; it is frequently crossed by veins of white quartz, and is found principally as small leaders which are usually very rich in gold. Many of these leaders have been worked at the Maid of Erin Hill and Trig Hill, Pine Creek. The writer has not yet had a chance to examine the pre-Cambrian amphibolites of North Queensland, but Rands's description of the Ebagoolah goldfield shows that there is a close similarity between this field and the Northern Territory goldfields. In the Coen and Ebagoolah fields one would expect to get the same two types of quartz as in Western Australia and the Territory.

Graphite in Lodes.—The widespread distribution of graphite in the lodes of Western Australia, the Territory, the Cloncurry district, Ebagoolah district, Croydon, &c., is one of the pronounced features of the north-central massif. The writer has shown (N. T. Bull. 16, and in an official report on Croydon not yet published) that the graphite is probably of chemical origin, due to interactions between limestone, hydrogen, water, and iron minerals at high temperatures with probably iron-carbonyl as an intermediate product of the reaction. He can see no reason for the belief that any of these graphites have been derived from coal seams. In studying the Gympie graphitic beds under the microscope, the writer found the plumbagiferous beds derived from tuffy limestones (submarine calcareous tuffs) with marine fossil remains rather than plant beds, while the lode graphites of other districts are probably of hydato-igneous origin. In other parts of the world, as in Ceylon and in the New York province, graphites occur chiefly in highly metamorphic rocks, and are probably of hydato-igneous origin.*

In the Northern Territory, on the margins of the great and igneous intrusions, and, in general, on the strike lines of the pre-Cambrian crystalline limestone belts, as at Krana Creek (Margaret district), Uwatha Tableland (Upper Cullen River), we get frequent large areas of andalusite and chiastolite-sillimanite rock, very rich in graphitic carbon (*see* N.T. Bulletin 16). There can be little doubt that this graphite was formed chemically from the metasomatism and silicification of calcareous carbonate rocks, and limy shales.

* See "The Origin of Graphite," by H. I. Jensen, D.Sc., Economic Geology, Jan.–Feb. 1922.

Bitumen was obtained by Drill-Foreman Berry in 1911 in boring on a silver-lead-zinc lode in Cambrian limestone country on Cattle Creek, about 10 miles from McArthur Station. Ball has recorded anthracite from the Silver King lode in the Burketown Mineral District (Q.G.S. Pub. 232, p. 30). In the writer's opinion these occurrences probably have no connection with true coal seams, but are purely of chemical origin.

Magnetite-Hematite-Quartz Lodes or Beds.—McLaren in his work on "Gold" says: "By far the most characteristic rock of the Archæan group, and one always associated with the sedimentary members of the series, is a well-banded, generally much-contorted, hematite-magnetite quartz rock, of obscure origin. It has been thought to arise from silicification along shearing planes, but it may most reasonably be regarded as due to the metamorphism of ferruginous silicate and carbonate bands in depth, with resultant conversion into ferric oxide and silica."

Although the writer has not diagnosed this rock type in the Territory, the allied "hematite quartz" rock occurs frequently in the Rum Jungle, Margaret, Mount Ellison, and other districts, and, as far as the writer's experience goes, it is always a shear formation and not of purely sedimentary origin. In the Cairns district in a greywacke schist series of much later (Devonian ?) age we get hematite quartz and hematite-magnetite quartz rocks which are certainly shear formations, the shearing having occurred on bedding planes. The original sedimentary rock substance has been supplemented by silica and mineralisers from below.

The ferriferous shears are always most freely developed in the Territory in regions where amphibolitic rocks abound—a feature which certainly points to the derivation of much of the iron through transport by mineralising solutions from the ferriferous amphibolite to the shear zones. The shear zones are channels in which metasomatism is affected by the agency of mineralisers carrying iron from basic and ultra-basic schists and intrusives, which they are simultaneously metasomatising.

Thus, one may reasonably deduce that the frequency of hematite-magnetite quartz zones in the Archæan is a sequence of the abundance of basic and ultra-basic intrusives ino thes formations.

In North Queensland ultra-basic rocks are abundant from Almaden to Charleston and Georgetown. As in the Territory, they are older than the granites.

Chloritic Rocks and Schists.—Throughout the Northern Territory and North Queensland tin areas chloritic schists and chloritic rocks are of very frequent occurrence, and are extremely favourable host rocks for tin deposition. They are frequently topazised in the vicinity of the lodes. In the Territory we have these rocks at Hidden Valley, Horseshoe Creek, Mary River tin field, Mount Todd, &c. We have at Maranboy a closely allied rock, but so intensely silicified as to be akin to hornfels. In Queensland they are the dominant rocks in the Koorboora and Irvinebank districts. In the Territory the "chlorite" areas are of late pre-Cambrian age, metamorphosed by the early Cambrian granites. In North Queensland they are usually regarded as coeval with the Silurian Chillagoe series*. The chlorite schists are unfossiliferous and possess the textural characteristics of metamorphosed volcanic tuffs.

The writer has observed that the period of granite intrusion, which was pre-Cambrian in the Darwin district, was continued into the Cambrian in the McArthur district (Yah Yah Creek); and possibly that would also be its age in the Mount Oxide region (Burke). It is quite possible that the volcanic period that produced the tuffs was an early manifestation of the igneous activity which later led to the "Older Porphyry" intrusions, and occurred progressively later as it made east. Thus the Koorboora-Irvinebank series may easily be as late as Ordovician, and the granites here Carboniferous.

The formation of chlorite points to tuffs having been covered with some thousands of feet of sediment and depressed into the Upper-Middle zone of the earth's crust prior to the igneous and hydato-igneous activity. The same rock types more intensely metamorphosed in a lower zone, where minerals of an anhydrous nature would form, become magnetite-hematite-quartz hornfels. This is a frequent type at Maranboy (Northern Territory).

* I have, however, come to the conclusion that the North Queensland chlorite schists are older than the Chillagoe series and probably of Orvodician age.

The tendency for tin to leave the deeper zones of metamorphism and to deposit in the upper middle zone, where hydration is permitted by the temperature pressure conditions, is thus evidenced by the association of tin with chlorite rock. Obviously reaction $SnF_4 + SiO_2 = SnO_2 + SiF_4$ is not favoured by high-temperature pressure conditions, in which hydrous minerals are unstable. The silico-fluorides, like topaz, pycnite, are almost universally hydrous. The SiF_4, as soon as formed, reacts with silicates to form these minerals. The chlorite rocks are therefore best regarded, not as an indication of a definite geological age but as the typical alteration product of certain tuffs when depressed to the upper " middle " zone of the earth's crust during a period granitic intrusion.

Apically, Medially, and Basally Truncated Batholiths.—Professor Butler, in " Economic Geology," March, 1915, has shown that for batholiths of the same magma those apically truncated are more favourable to rich mineral occurrences than those medially and basally truncated. In general that holds true for the Territory, where the writer has investigated the matter. It is also the writer's experience that apically truncated batholiths are characterised by a more aplitic type of granite than usual, often called " sandy granite."

In areas of general plateau uplift, continued through great periods, there will naturally be extensive areas of granite, constituting medially and basally truncated batholiths. Those areas are not favourable to the prospector. Alluvial tin, gold, and wolfram occur widely on them in small quantities, but large lodes are few or absent.

It is on those parts of the massifs over which the schists and metamorphosed sediments are only partly removed, and the underlying granite exposed only here and there in valleys, or as a central boss with schists dipping away from it all round, that one would search with most prospect of success for payable lodes.

In the Territory the Maranboy and Coronet Hill fields are such areas. Tanami is another in which erosion has not yet exposed the granites anywhere. The heads of the Katherine, Alligator, Limmen, and McArthur Rivers are also in areas where apically truncated batholiths will be found. In North Queensland apically truncated stocks will most frequently occur around the edges of the northern massif, along the belt of erosion of the Silurian festoon moulded on the massif.

This is confirmed by the location on the map of the principal mineral fields of North Queensland. Commencing at Rocky River and running our pencil south, we pass through the Hamilton, Coen, Ebagoolah, and Palmer goldfields, the O.K., Chillagoe, and Tate mineral fields, Einasleigh and Kidston, and thence south-west through Gilberton, Woolgar, and after a Cretaceous overlap, the Cloncurry field. On the massif itself the areas offering most promise of new finds are the Woollagorang–Lawn Hills area on the border and those already mentioned in the Territory—viz., the Tanami area and the Upper Limmen, McArthur, Katherine, and Alligator River districts. These areas and the border festoon will yield mineral wealth for ages to come.

Nature of Lodes on the Massifs and Cordillera Compared.—The lodes of the massifs (*i.e.*, in pre-Cambrian formations) are frequently large and permanent. They vary from high grade to low grade. Many have been tried in the Territory after the richer surface ores have been worked out, and in numerous instances the magnificent early yields justified more thorough exploration of the deeper zones, although transport difficulties made it unprofitable to work any but the richer ores.

There is no doubt that, with improved communications and transport facilities, mines like the Iron Blow (Yam Creek), Mount Bonnie (Margaret River), Coronet Hill, Daly River copper mine, Eureka, and Evelyn will be reopened and worked for lower-grade sulphides.

When that time comes it will be essential to have a study made of the sulphides occurring below the water level to determine in the case of each mine whether they are primary, or of secondary origin. In an area of plateau movement it would be quite possible for bodies of carbonate and oxide to exist below a zone of secondary sulphides. This possibility, being of great economic importance, deserves close study.

The large permanent fissure lodes and shear zones of the massifs are frequently gossan-capped, passing into massive sulphides below. In the Cordilleran area a quartz matrix predominates, both in the surface and sulphide levels.

In the Palæozoic folded rocks of the Cordilleran area the lodes themselves have been so disturbed, both by Palæozoic and later folding, that they are reduced to discontinuous lenses.

SUMMARY AND TENTATIVE CONCLUSIONS.

1. North Queensland, from Cloncurry to Cape York, forms part of the North-Central massif of Australia, which is predominantly of pre-Cambrian age, and which has not been affected by any compressional forces since the early Cambrian.

2. Festoons of progressively more recent folded rocks envelop the massif.

3. The massif has been subjected to plateau movements only. As a result, the lodes on it are strong and permanent, with a likelihood of oxidised bodies occurring below the first sulphide zone encountered.

4. The apically truncated batholiths of the massif and in the Silurian festoon are most favourable for the prospector. Grano-aplites are the characteristic rocks of apically truncated stocks.

5. Basic eruptives, altered to amphibolites, two quartz types (blue and white), magnetite-hematite-quartz rocks, hematite-quartz rocks in shear zones, and lode graphite, are features of massif petrography.

6. The North-Central massif of Australia is characterised by Archæan trend lines in a west-north-west direction. Reference to Suess' "Das Antlitz der Erde" and to his maps showing the trend lines of the five continents will show that the dominant trend lines in the southern hemisphere are west-north-west for tropical, and north-west for temperate regions; and in the northern hemisphere east-north-east for tropical and north-north-east for temperate regions. This feature, being most pronounced in Archæan structures, points to greater plasticity on the earth's crust in Archæan times than in later periods, and affords confirmation of the Lamarckian theory of earth origin.

7. The Cordilleran belt of Australia, from the Kosciusko massif to Whitsunday Passage, is essentially a fold region or geosynclinal. Owing to intense folding it is not so favourable for the occurrence of strong continuous lodes as the massif areas.

8. The Cordilleran belt passes out under sea somewhere north of Mackay, and possibly swings out to New Caledonia, a large portion of the geosynclinal ranges having been resubmerged by extensive trough faulting.

Obviously, conclusions can only be tentative, as data are sadly wanting in regard to trend lines. Present-day mountain ranges not infrequently, as in the case of the Victorian Alps, do not correspond to the directions of folding. Certain propositions are, however, advanced in this paper for further investigation. Certain queries of world-wide geological interest arise.

Why are tropical regions essentially plateaux and submerged plateaux regions ? Were equatorial regions in Archæozoic times dominantly continental ? Was there a strong rock flowage in the upper earth's crust giving rise to west-north-west trends in southern latitudes and west-south-west trends in northern ?

Other matters touched on, as, for instance, the questions of lodes and mineral resources, are more purely of Australian interest.

The questions raised are not for one geologist to solve. They require the collaboration of all.

Geology and Petrology of the Enoggera Granite and the Allied Intrusives.

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PART II.—PETROLOGY.

(Plates I.-III.)

(Read before the Royal Society of Queensland, 26th June, 1922.)

I. INTRODUCTORY.

In November, 1914, the author had the privilege of reading before this Society the first part of a paper entitled "Geology and Petrology of the Enoggera Granite and the Allied Intrusives."[1] This dealt with the general geology of the area, and it was the author's hope that it would be followed, after a short interval, by the second part of the paper, which was to deal more particularly with the Petrology. Much of the work required for this part of the paper had been done, but its publication has been very much delayed, chiefly as the result of the author's absence abroad with the Australian Imperial Forces.

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[1] Proc. Royal Soc. Qld. Vol. XXVI. p. 141.

II. GENERAL PETROLOGY.

The rocks dealt with fall into two main groups—viz., the granitic and granodioritic rocks forming the outcrops at Enoggera, Green Hill, and Kedron Brook, and intrusives of a rhyolitic and porphyritic nature which are intimately associated with the former series, and which are believed to be genetically related to them.

The former group is called locally the "Enoggera Granite," and is best known from the building stone which has been very largely used in and about the city of Brisbane, and which is obtained from a quarry on the left bank of the Enoggera Creek. This rock has been dealt with by Professor H. C. Richards, D.Sc., mainly from the economic aspect.[2] This particular variety cannot, however, be regarded as typical either of the group of granitic rocks as a whole, or even of those forming the outcrop of the principal Enoggera area.

The most marked feature of the granitic group petrologically is the wide variation of type to be met with for such a restricted area of outcrop. This variability is both chemical and textural. Mineralogically the variation is not so marked, the different rock types resulting rather from differences in the proportion of the minerals present than in actual differences in character and appearance of the minerals themselves.

In the face of such wide differences in the field it is at first difficult to generalise, but it seems to the writer that this variability can be revolved into—

(1.) Two main phases, which for convenience we may term the Pink and the Grey, which differ chemically as shown by a comparison of the Rock Analyses E1 and E4, and mineralogically in the proportions of the minerals present.

[These were referred to in the earlier part of this paper (p. 150) as the "adamellite type" and "granodiorite type" respectively. While the author has every reason still to regard the "Grey Phase" as being essentially granodioritic, he now doubts the wisdom of referring to the "Pink Phase" as an adamellite type. If one

[2] Proc. Royal Soc. Qld. Vol. XXX. p. 101, and Plate X., fig. 13.

uses Hatch's simple criterion[3] then since the Orthoclase and Plagioclase felspars are present in approximately equal amount the rock is an adamellite. Further, the analysis of the Pink Phase (Analysis I.) is remarkably close in all its essentials to that quoted by Hatch p. 179, as "iv. Adamellite, Shap."[4] However, these analyses also agree in differing somewhat sharply, both in amount and proportion of the alkalies, from Analyses I., II., and III., which are presumably more typical adamellites.]

(2.) A wide variability within both the light and dark phases, which, however, is textural merely and not chemical, as is seen by a comparison of the mineral contents of specimens very dissimilar texturally, which show plagioclases of the same chemical composition and in which the other minerals are identical.

(3.) In addition to the former varieties we occasionally get others which depart rather widely from the more typical rocks in the proportion of the minerals present. Of these, only one forms outcrops of any importance, and this is remarkable in that it appears to have some important characteristics in common with each of the phases. It is not so much a mineralogical average of the Pink and Grey Phases as a mineralogical mixture. At first sight it appears to represent a connecting link between the phases, but the discussion of this question is deferred. The rock in question is to be seen outcropping at the Quarry on Enoggera Creek.

One might reasonably expect that such marked chemical differences as those shown in the analyses (E1 and E4) of the two phases would be reflected in their distribution in space or in time.

With regard to distribution in space, rocks representative of the Pink Phase cover roughly three-quarters of the main Enoggera area of outcrop and all of the Green

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[3] Hatch, "Petrology of Igneous Rocks," p. 164.

[4] Op. cit. p. 171.

Hill area, while the Grey Phase occupies one-quarter of the Enoggera area and the whole of the two outcrops at the Kedron Brook area. Further, the latter phase is usually restricted to the more deeply dissected or more central portions of the Enoggera area, the highest points and peripheral portions being almost invariably occupied by the aplitic, fine-grained and "sandy" granites which form a distinct type of the Pink Phase. The vertical section in the central part of the Enoggera area, obtained by descending into the valley of the Enoggera Creek from the heights lying to the north, gives in descending order the following sequence:—

Aplitic and "sandy" granites }
Typical Pink Phase } Pink Phase.
Pink Phase with included fragments of Grey Phase.
Typical Grey Phase.

A similar sequence is often, but not always, found in passing from the periphery towards the centre of the area.

This arrangement of the dark and light phases seems at first glance to suggest a differentiation into two main types as the result of gravitative separation, but a closer study of the relationship of the phases does not support such an hypothesis.

The only indications which have been noted which suggest any difference in the time of intrusion of the two phases appear at first sight to be contradictory.

In some sections the Grey appears to intrude the Pink Phase as dykes, but in many other sections it is definitely surrounded by the Pink Phase and forms irregular inclusions or "segregations" of very variable size. While some of the smaller of these are undoubtedly segregations in the strict sense of the word, the vast majority of the larger ones appear to be fragments caught up by the enclosing magma.

There is thus some evidence that part at least of the Grey Phase is later in age than the Pink, but the weight of evidence points to the Pink as being the later phase. These two groups of evidence, though apparently contradictory, may perhaps be reconciled in the following way:—The Pink appears to have broken through the Grey rock, carrying fragments of varying size with it. Later the underlying dark rock may, as the result of heat or pressure changes, have become molten again and have been forced up into the cooler overlying Pink Phase as intrusions.

The field evidence thus appears to indicate that the two phases are not the result of differentiation in place, either by gravitative or other methods, and that the Pink Phase is younger than the Grey, and that, further, the aplitic and sandy granites are later than the more normal type of the Pink Phase. Thus we see that the order of succession is Grey Phase followed by typical Pink Phase, which in turn is followed by the aplitic and "sandy" granite types of this phase, with finally a reversion to the basic or Grey Phase. This is the order of primary differentiation of Brögger, who, to quote Harker, believes in "an order of increasing acidity with in many instances a final reversion to basic types."[5]

It is interesting to note that this relationship is strictly analogous with the sequence of intrusions in New England, the Moreton district of Southern Queensland, and that of Charters Towers of Northern Queensland, but more detailed comparisons with these areas are made later in the paper.

The following rock analyses give a general idea as to the chemical relationships of the two phases. Analysis E1 is that of a rock selected as typical of the Pink Phase, while Analysis E4 is that of a rock typical of the hornblendic type of the Grey Phase. Analysis E2 is the only other analysis from the area and is that of the "Enoggera Granite" used largely as a building stone, and which mineralogically presents important points of similarity with both phases. Analysis E3 is that of the Mountain Camp rock, a few miles to the north of Enoggera.

The precise position of E2 and its relationship to the Pink or to the Grey Phases is a question about which the author has long been in doubt. In appearance it resembles neither a typical granite nor a typical granodiorite. The grey colour, the relative basicity of the plagioclases, the absence of pink orthoclase and the abundant pyrites were all points in common with the Grey Phase, but the high acidity of the rock and the marked

[5] Eruptivgesteine des Kristianiagebietes," II. (1895), pp. 165-181.

preponderance of biotite and the specific gravity were factors in common with the Pink Phase.

TABLE 1.

——	Pink Phase. E 1.	Grey Phase. E 4.	(?) Hybrid. E 2.	Calculated Rock. A.	Mountain Camp Rock. E 3.
SiO_2	73·52	61·10	71·50	70·41	61·54
Al_2O_3	11·05	19·24	14·13	13·10	19·03
Fe_2O_3	Nil	} 4·66	0·60	} 3·53	Nil
FeO	3·15		3·23		5·04
MgO	1·03	2·56	1·17	1·41	2·97
CaO	1·70	5·25	2·70	2·59	4·90
Na_2O	4·08	3·82	2·97	4·01	2·84
K_2O	3·99	1·68	2·86	3·41	2·76
H_2O + ...	0·44	1·31	0·32	0·66	0·35
H_2O −	0·16	0·64	0·10	0·28	0·10
CO_2	..	..	..	..	..
TiO_2	0·20	..	0·41	..	0·72
P_2O_5	0·15	..	0·35	..	0·08
Total	99·48	100·26	100·34	99·40	100·33
Sp. Gr.	2·58	2·71	2·59	..	..
NORM: Quartz	30·24	14·82	34·32	..	15·00
Orthoclase ..	23·35	10·01	16·24	..	16·68
Albite	34·58	32·49	25·15	..	24·10
Anorthite ..	..	26·13	11·40	..	24·46
Diopside	6·34	..	..	..	..
Corundum ..	..	1·43	1·84	..	2·24
Hypersthene ..	4·67	11·55	8·52	..	16·64
Magnetite ..	..	1·86	0·93	..	..
Ilmenite	0·46	..	0·76	..	1·37
Apatite	0·34	..	0·67	..	..
Symbol	I. 3.1.3.(4) Alaskose	II. 4.3.4 Tonalose	I. 3.2.3 Tehamose	.. ..	II. 4.3.3(4) Harzose

This rock, as the result of the opening of new quarries, has proved to be considerably more extensive than the author first thought. If, as its mineralogical contents and chemical composition both suggest, it is related to *both* phases, there are only three possible modes of origin—

(1.) That it is the parent magma from which both the Pink and Grey Phases sprang;

(2.) That it is an intermediate member of a series E1-E2-E4, thus linking the two phases; or

(3.) That it is the result of admixture of the Pink and the Grey Phases.

The first idea that it may represent part of the parent magma or undifferentiated portion is refuted by the evidence as to the two main magmatic series in Southern Queensland, to be discussed more fully later in the paper. Further, in the light of modern petrology we can hardly postulate the splitting of such a magma as that represented by Analysis E2 into two parts such as those we see in analyses E1 and E2. Such an hypothesis as the second might explain the intermediate chemical composition, but does *not* explain the mixed mineralogical nature of the rock.

The only alternative remaining is that this curious rock is produced by admixture of two distinct rock types. It seems to be what Harker terms "a hybrid."

By weighting the Analyses E1 and E4 in the proportion 3:1 (a ratio already mentioned as that of the outcrops of the two phases in the somewhat deeply dissected Enoggera area) we obtain the hypothetical rock which would be produced by the admixture of the Pink and Grey Phases in the proportions in which we believe them to exist. The chemical composition of such a rock is represented by Analysis A, which is seen to agree quite closely in many respects with Analysis E2.

In comparing the calculated Analysis A with the actual Rock Analysis E2, it is seen that while the value of the calculated CaO is somewhat less than the actual, both the alkalies are considerably in excess, although the proportion K_2O : Na_2O is much the same. This is not unexpected, for Harker[6] in discussing the calculation of the chemical composition of hybrid rocks points out that while in bulk the hybrid rock must be a linear variation of the two unmixed rocks, differences may be expected in the chemical composition of the rock specimens analysed. The example quoted by this eminent authority resembles the present case in that the CaO found in the hybrid rock is less than the calculated, the difference being that in Harker's case the discrepancy is considerably greater. This is explained by Harker as probably due to difference in the rate of diffusion of CaO on the one hand and of the alkalies on the other. Hence the divergences to be expected are precisely those found to exist in the present case. The calculated value of CaO will be less than that of the actual, while that of the alkalies will be greater and further as the rates of diffusion of the potash and soda molecules are very nearly identical, the proportion K_2O : Na_2O as calculated should agree very nearly with the proportion found by actual rock analysis.

[6] "The Natural History of Igneous Rocks," p. 358.

If, then, the rock is a hybrid, we might expect it to betray its mixed origin more directly in its chemical composition. The most remarkable feature of the Analysis E2 is the practical equality and low values of CaO, Na_2O, and K_2O. In this combination the analysis differs markedly from all the analyses of average acid plutonic rocks compiled by Clarke, Daly, and Osann, to which the author has access. Further, a search was made through the ninety-six analyses of rocks placed in the same subrang (Tehamose) in Washington's "Superior Analyses of Fresh Rocks" for similar types.

A noticeable feature of the analyses was the wide range in the absolute and relative values of CaO, Na_2O, and K_2O, a point to which the author naturally gave much attention. One analysis was found which is remarkably close to E2, especially in the alkalies and alkaline earths; but—and this the author considers very significant—it is not strictly an igneous but a metamorphic rock. It is No. 9 in Washington's list for the subrang, and is described as a granite gneiss from Virginia, U.S.A.[7]

The analysis next most like that in question is No. 2, a Hypersthene Adamellite from Havnefjord, Ellesmere Land, and is patently not a normal granitic type. No. 61, Tonalite Porphyrite, from the Tyrol, and No. 65, Adamellite from Switzerland, approach the Enoggera hybrid in some respects, and a curious series of rocks from Japan, notably the "Granite" No. 79, seems to provide a somewhat similar rock.

The evidence, on the whole, seems to uphold a hybrid origin for the Enoggera building-stone.

It is interesting to note here that Jensen suggests that the Cooroy Monzonite and the Pt. Arkwright Porphyrite, both some 75 miles to the north of Enoggera, are "made up of a mixture of a dioritic magma with the aplitic differentiation product . . . ."[8]

Further consideration of this important question of hybridism in the Enoggera area will be given in that portion of the paper dealing with comparisons of the local granitic rocks with those of other areas.

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[7] "A Description of the Quantitative Classification of Igneous Rocks," 1918, p. 81.

[8] "Geology of the Volcanic Area of the East Moreton and Wide Bay Districts, Queensland." Proc. Linn. Soc. N.S.W. 1906, p. 132.

(III.) PETROGRAPHY.

(*a*) The Pink Phase.

This phase is characterised by its high acidity and the consequent presence of quartz in considerable amount; by its pink orthoclase, which is usually slightly in excess of a white soda rich plagioclase, and which gives the rock its typical colour; and by biotite, which is usually present though not in any great amount. Hornblende is either absent or rare. Pyrites is absent. Associated with the Pink Phase proper are modifications of it of an aplitic and granophyric nature, which occur generally near the margins of the granite and capping the higher hills, and sometimes as distinct intrusions through the Pink Phases. These modifications are slightly later in time of intrusion than the typical pink rocks, and are almost certainly the equivalents of the "Euritic" series of Andrews and the "Aplites and Sandy Granites" of Saint-Smith in New England and Stanthorpe respectively (*see* Table II.). In the Enoggera area they are so intimately associated with the Pink Phase proper that it does not seem advisable to treat them as a separate group.

The following descriptions give some idea of the rock types found in this phase.

The bracketed numbers refer to the special "Enoggera" collection of rocks, while the other numbers are those of the collection of Microslides. Both are the property of the Geology Department, University of Queensland.

(*G. 1*) 141. (*See* Micro-photograph Pl. II., No. 1, and analysis E1.)

Specimen from southern part of main Enoggera mass.

Megascopic.—A pink holocrystalline, porphyritic rock, composed of medium-sized phenocrysts of quartz, pink orthoclase, white plagioclase and black mica set in a fine-grained flesh-coloured ground mass.

Microscopic.—The porphyritic character of the rock is marked and the proportion of phenocrysts to ground mass somewhat variable (Sempatic to Dopatic of Iddings). The *ground mass* is made up for the most part of quartz and felspar, sometimes irregularly intergrown, with occasional small crystals of green biotite. The *quartz phenocrysts* are from 1-3 mm. in diameter and occur as allotriomorphic and rounded crystals, frequently fractured and containing numerous dust-like inclusions. In addition to these there are other small inclusions of biotite and larger ones of orthoclase and plagioclase. In one quartz crystal is enclosed an aggregate of quartz and felspar closely resembling the ground mass, but this may be the infilling of a deep embayment. *Orthoclase* occurs as hypidiomorphic phenocrysts which are considerably altered. These often include patches of another felspar intergrown in perthitic fashion. The *plagioclase phenocrysts* prove to be Albite-Oligoclases, and occur as large hypidiomorphic crystals which exhibit twinning on both the Carlsbad and Albite laws. *Biotite* occurs as brownish-green phenocrysts which become reddish-brown on alteration, and which show the characteristic strong absorption and perfect cleavage. Inclusions of zircon and apatite are sometimes found. *Magnetite* occurs in idiomorphic crystals and a few needles of *Apatite* are present. *Zircon* is present in small amount.

Order of consolidation of phenocrysts.—Normal.

In the ground mass quartz and orthoclase solidified at approximately the same time.

Name.—Granite Porphyry.

Note.—Among the many recommendations embodied in the "Report of the Committee on British Petrographic Nomenclature" is one that "The name granite-porphyry is ambiguous, and should not be used." This name has found considerable use in Australian petrographic literature, where it has a quite-definite meaning. The rock described above is so like many other Australian so-called "Granite-porphyries" that, principally for purposes of correlation, the author has deemed it wise to retain the term.

(*G. 2*) 150. (*G. 4*) 152.

These two specimens also come from the southern part of the Enoggera area. They are very like the rock described above in most respects, but there is seen in these slides a definite tendency for the felspar phenocrysts to be closely grouped together.

(*G. 8*) 156.

This specimen comes from the N.N.E. portion of the main Enoggera outcrop.

Megascopic.—A pink medium-grained rock made up of colourless quartz, pink orthoclase and white plagioclase, together with a little green mica.

Microscopic.—Holocrystalline rock of medium and fairly even grain. *Quartz* occurs in allotriomorphic crystals from 1-4 mm. in diameter. It is fresh, shows radiating fractures, and contains numerous large inclusions of felspar and many dust-like inclusions. *Orthoclase* is present generally in somewhat altered crystals, from 2-4 mm., showing Carlsbad twinning. Inclusions of both plagioclase and biotite occur. The *Plagioclase* felspar is a somewhat acid andesine. It occurs in smaller crystals than the orthoclase, and shows both Carlsbad and Albite twinning. Microcline is also present showing the characteristic combination of Albite and Pericline twinning. *Biotite* occurs as a few comparatively small dark green crystals which are partly altered to chlorite and contain a few inclusions of apatite. *Magnetite* is present in small amount and shows in places alteration to Limonite.

Order of consolidation.—Normal.

Name.—Biotite Granite.

(*G. 9*) 157.

This specimen comes from N.N.W. part of the Enoggera area.

Megascopic.—A medium-grained pink rock made up of colourless quartz, pink orthoclase, cream plagioclases, and a dark mica.

Microscopic.—Holocrystalline, medium grained. *Quartz* occurs as numerous allotriomorphic and interstital crystals from 1-3 mm. in diameter, considerably fractured, with inclusions of plagioclase, orthoclase, biotite, and apatite, and numerous small dust-like inclusions. Quartz also occurs intergrown with orthoclase and rarely as inclusions in orthoclase crystals. *Orthoclase* occurs in hypidiomorphic and allotriomorphic crystals from 1-3 mm. in diameter. It usually shows some alteration to sericite or other micaceous products. It is sometimes intergrown with quartz and often shows inclusions of plagioclase, biotite, and quartz. The principal *Plagioclase* present is an albite-oligoclase, but an acid andesine is also present; and further, a zonal structure is sometimes seen. These felspars vary from 1-3 mm. in diameter and show Albite twinning commonly and Pericline twinning occasionally. They contain as inclusions crystals of biotite. *Biotite* occurs as brown and light green crystals strongly pleochroic, with inclusions of *Apatite*.

Order of crystallisation.—Normal.

Name.—Biotite Granite.

(*G. 26*) 422.

This is typical of the outcrop of the Pink Phase forming the Green Hill area to the south of the main Enoggera area. (*See* Microphotograph Plate II., No. 2.)

Megascopic.—This is a holocrystalline, porphyritic rock made up of phenocrysts of colourless quartz, white felspar and black mica set in a fine-grained pink ground mass. The rock is somewhat darker in appearance than the specimens from the principal area described above, and differs from them in the almost complete absence of phenocrysts of pink orthoclase.

Microscopic.—Holocrystalline, porphyritic. The medium size of the felspar phenocrysts, the fine-grained ground mass and the general arrangement, including the tendency of the felspar phenocrysts to form clusters, are all characters in which this rock approaches very nearly the rocks from the southern part of the main Enoggera area. (Compare Nos. 1 and 2 of Plate I.) The ground mass is made up of a microcrystalline mosaic of quartz and altered felspars, which, judging by the pink colour of the ground mass as seen in the hand specimen, are mostly orthoclase.

Quartz occurs as comparatively small rounded crystals usually from ½-1 mm. in diameter. Further, this mineral is not so abundant as in the specimens described above. *Orthoclase* phenocrysts are rare. The *Plagioclases* present are all strongly zoned, so that it is difficult to calculate from them the proportion of lime to soda in this rock. *Biotite* of the usual type is present. *Magnetite* and *Apatite* are present in very small amount.

Name.—Granite (Granodiorite?) Porphyry.

Associated with the Pink Phase, but a little later as regards time of intrusion, are aplitic and granophyric rocks which, however, do not merit detailed descriptions, since they are quite normal in most respects. In the former, however, flakes of molybdenite are occasionally found, while the latter sometimes show very beautiful micrographic intergrowths of quartz and orthoclase. (*See* Plate II., No. 3.)

(*b*) THE GREY PHASE.

Under this heading are included a number of rock types which, though they differ in some respects, have in common several characteristics which mark them off clearly from the "Pink Phase." In general the rocks of this phase are of a grey colour. Quartz is not so abundant as in the other phase (pink orthoclase is absent), and the plagioclases are more calcic, the phenocrysts usually being acid andesine and the felspars in the ground mass an intermediate andesine. Hornblende is usually present, sometimes in great abundance. Pyrites is invariably present, sometimes in considerable amount.

The rocks of this phase vary between two types. Of these the first is characterised by the very strong development of numerous long prismatic and acicular crystals of hornblende, which give the type quite a distinctive appearance. This rock occurs as inclusions, and larger masses set in and surrounded by the Pink Phase. They are evidently the remnants of an older rock. Although they are marked off from the enclosing mass by a well defined boundary, there is evidence that the hornblendic rock has been in some cases somewhat modified by the enclosing acid magma. In particular, one very interesting rock has resulted from a partial mixing of the two types. In the hand specimen it suggests mechanical mixing rather than chemical intermingling, although evidence of chemical interaction is seen on a closer inspection. The specimen examined was obtained from Portion 373, parish of Enoggera, and presents a curious appearance, irregular pink patches being scattered through the dark hornblendic rock. Numerous rounded quartz blebs occur sporadically throughout the rock, and each is surrounded by a very distinct corona of ferro-magnesian minerals. This suggests that at least some chemical interaction took place.

The second type of Grey Phase is not nearly so conspicuous as the first, but is probably present in greater amount, occupying as it does a considerable portion of the western and north-western portions of the Enoggera area. This type is finer grained, of a grey colour, has considerably more biotite present (usually in small crystals), and often has present quartz and felspar intergrown to give a rudimentary granophyric structure. The plagioclases are again andesines, and pyrites is always present. This type is sometimes found as inclusions in the Pink Phase and occurs as small zenoliths in the Enoggera (?) Hybrid. (*See* Microphotograph Plate III. No. 8.)

(*G. 44*) 416.—Specimen from Portion 374, parish of Enoggera.

This is representative of the hornblende rich type of the Grey Phase. (*See* Microphotograph Plate II. No. 4, and Analysis E4.)

Megascopic.—This rock has a remarkable appearance in the hand specimen. Numerous long slender crystals of hornblende, ranging up to 8 mm. in length and averaging about 4 mm. are set in a fine-grained light-coloured base and give the rock a pseudoporphyritic character. Pyrites is present in small amount.

Microscopic.—Fine-grained holocrystalline for the most part, but with large crystals of hornblende. *Quartz* is present but not very conspicuous, occurring as small allotriomorphic crystals and irregular patches. The felspars are for the most part clouded with decomposition products, but seem to consist for the most part of plagioclases. Some of the altered felspathic material shows a tendency for vague intergrowth with the quartz, and this is presumably *Orthoclase.* The plagioclases still show indistinctly traces of Albite twinning, very few of them being determinate. Those sections capable of determination by the Michel-Levy method show a variation from *intermediate to basic andesines. Hornblende* occurs in numerous elongated, relatively large crystals, which give an apparently prophyritic character to the rock. This impression is contradicted by two facts—first, there is no sign that the hornblende is present in two generations; and second, that the small plagioclases are idiomorphic to these large hornblende crystals, showing clearly that at least the latter part of the growth of the hornblendes was subsequent to the consolidation of the plagioclases. This is, of course, seen best in prismatic sections of the hornblende, transverse sections often showing beautifully idiomorphic outlines with both sets of cleavages well developed. The mineral is light-green in colour, strongly pleochroic, and shows alteration to Chlorite. *Biotite* is very rare, but those few small crystals present are definitely idiomorphic to the hornblende. *Augite* is present in three very small crystals. *Magnetite* is present in considerable amount, but is largely pseudomorphous after *Pyrites*. *Sphene* and *Apatite* are present, but in very small amount.

Order of consolidation.—Biotite, Andesine, Hornblende, Orthoclase, Quartz.

Name.—Hornblende Quartz Diorite.

(*G. 41*) 345.—Specimen from near "The Summit," Taylor Range.

This forms a connecting link between the more typical hornblendic rock (G. 44) on the one hand and the biotitic rock (G. 14) on the other.

Megascopic.—A grey holocrystalline fine-grained rock, made up for the most part of white plagioclase and dark hornblende, together with very small flakes of biotite and numerous small crystals of pyrites.

Microscopic.—Holocrystalline, fine-grained. *Quartz* occurs as interstital growths, which (since the other minerals are strongly idiomorphic) are bounded by numerous short straight lines running at various angles, thus giving a curious graphic appearance to the mineral. Other somewhat larger plates are seen enclosing smaller crystals of all the other minerals. *Orthoclase* occurs as a few comparatively large, irregular crystals (up to 3 mm.), idiomorphic only to the quartz and showing perthitic intergrowths with another felspar. *Plagioclase* is present as numerous, mostly small, idiomorphic crystals, showing fine Albite twinning, but with a zonal extinction pointing to a considerable variation in chemical composition in each individual. In addition to these felspars is a large irregularly rounded crystal of plagioclase. The round outer edge of this is optically discontinuous with the remainder, and is evidently a "reaction rim." The crystal proper shows both Carlsbad and Albite twinning and is considerably larger and quite different in appearance from the plagioclases of the enclosing rock. It is evidently a xenocryst. Unfortunately the section is in such a direction that the plagioclase is indeterminate. *Hornblende* occurs as numerous acicular crystals showing marked pleochroism and in some stouter crystals, these latter showing intergrowths with biotite. *Biotite* is present in small amount, generally in irregular patches associated with the hornblende. *Pyrites* occurs as numerous small crystals scattered throughout the slide. *Apatite* is present as abundant minute crystals.

Order of consolidation.—Normal.

Name.—Hornblende Microgranodiorite.

(*G. 14*) 418.—Specimen from western part of area.

This is representative of the second or biotitic type of the Grey Phase.

Megascopic.—A grey fine-grained holocrystalline rock composed of occasional phenocrysts of quartz and white felspar set in a grey even-grained ground mass. Some small veins of pyrites are apparent.

Microscopic.—Only one undoubted phenocryst (an altered felspar) was seen in the slide examined, the rock being made up of a fine-grained but somewhat variable aggregate of quartz felspar hornblende and biotite. The quartz occurs in very irregular crystals moulded about and enclosing all the other minerals. Occasionally, however, the quartz crystals have moulded about them a discontinuous ring of small ferro-magnesian minerals. *Orthoclase* is present as hypidiomorphic crystals which sometimes show simple Carlsbad twinning. *Plagioclases* are numerous and seem to be divisible into two groups, the first a medium oligoclase and the second an oligoclase-andesine. A felspathic xenocryst with similar outline and reaction phenomena to that described above in No. 345 is present in this slide. It shows no twinning, however, and resembles anorthoclase in general appearance. *Hornblende* occurs in comparatively large elongated green crystals which are largely altered into chlorite. *Biotite* is present as numerous flesh flakes of a brown colour. The ferro-magnesian minerals show a distinct tendency towards segregation into definite groups. *Magnetite* occurs as fairly numerous crystals. *Apatite* is present as very small needles generally included in the other minerals. *Sphene* and *Zircon* are also present, but in much smaller amounts.

Order of consolidation.—The order of consolidation is not normal, and the various minerals "overlap" very much more than is usually the case. Some of the plagioclases are definitely earlier than some of the hornblendes, while others are just as definitely later. The same overlapping is noticeable with hornblende and biotite. Even some of the quartz crystals appear to be earlier than the small flakes of biotite which partly surround them. The ferro-magnesian minerals often appear as clusters illustrating the "together-swimming structure or synneusis struktur" of Vogt[9], which is characteristic of those minerals segregated from the magma at an early stage. But in this case they were certainly preceded by some at least of the plagioclases.

Name.—Granodiorite.

(*G. 18*) 421.—Specimen of Grey Phase from the southern of the two Kedron Brook outcrops.

Megascopic.—A grey rock made up of small phenocrysts of felspar and a ferro-magnesian mineral set in a very fine ground mass.

Microscopic.—Holocrystalline, porphyritic with small to medium phenocrysts set in a very fine-grained microcrystalline ground mass of quartz and felspar. *Quartz* occurs as rounded and embayed phenocrysts from ·5-1 mm. in diameter. *Orthoclase* is present as medium-sized phenocrysts very much altered by weathering. *Plagioclase* is present as medium-sized phenocrysts of Andesine very much altered, *Biotite* is present as ragged crystals, and *Hornblende* as long prisms both considerably altered.

Name.—Granodiorite Porphyry.

[9] "Magmatic Differentiation of Igneous Rocks," Journal of Geology, Vol. xxix. p. 321.

(c) The (?) Hybrid Rock.

This occurs as a patch a few acres in extent on the left bank of Enoggera Creek and about one-third of a mile from the eastern edge of the granitic mass. It is entirely surrounded by rocks typical of the Pink Phase. This rock has been quarried and used to some extent in public buildings in Brisbane and for kerbing purposes. It is known commercially as the "Enoggera Granite." (*See* analysis E. 2 and microphotograph Plate III., No. 7.)

(*G. 6*) 154.—From the Quarry, Enoggera Creek.

Megascopic.—In the hand specimen the preponderance of the light-coloured "salic" minerals over the dark-coloured "femic" minerals and the small size of individuals, and especially those of the latter group, give to the rock a somewhat curious "pepper and salt appearance,"[10] and a general absence of relief.

Microscopic.—Holocrystalline, medium-grained, the grain size, however, being somewhat variable, the resulting texture resembling the "seriate porphyroid fabric" of Iddings. *Quartz* occurs as allotriomorphic crystals from 1-3 mm. in diameter, fresh, generally unbroken, enclosing numerous large crystals of felspar. It also occurs commonly with orthoclase in micrographic intergrowths. *Orthoclase* occurs as hypidiomorphic crystals of varying size, sometimes as inclusions in quartz and sometimes in micrographic intergrowths. Carlsbad twinning is seen and inclusions of another felspar tend to give a rudely perthitic structure. It is usually considerably darkened and altered. The *Plagioclases* present are mostly intermediate andesine. A few crystals of oligoclase-andesine are present, and in addition there are a number of zoned plagioclases. Albite twinning is common, and Pericline twinning combined with Albite is not infrequent. All these felspars are darkened as a result of decomposition, and while some crystals are hypidiomorphic, the majority of them, and particularly the more basic, show irregular embayed and corroded outlines. *Biotite* occurs as rather small brown and green crystals, sometimes considerably bleached and altered into chloritic material and usually strongly pleochroic. *Hornblende* occurs very sparingly as green idiomorphic pleochroic crystals. *Pyrites* occurs commonly, generally in

[10] H. C. Richards, Op. cit. p. 102.

association with the ferro-magnesian minerals, both as well-shaped individual crystals and somewhat irregular clusters. *Magnetite* and *Apatite* are also present in small amount.

Order of consolidation.—Normal.

Name.—Biotite Granodiorite.

It is difficult to reconcile this rock mineralogically with either the Pink Phase or the Grey Phase. The abundance of quartz and the great excess of biotite over hornblende are points in comon with the former, while the absence of pink orthoclase, the nature of the plagioclases, and the abundant pyrites are more like the latter.

A comparison of the soda and lime content in analyses E. 1, E. 2, and E. 4 would lead us to expect in this rock plagioclases intermediate in character between those of the Pink and Grey Phases, and the calculated norms also predict such a result. However, measurements of the extinction analyses of suitable sections of felspars (Michel-Levy's method) in many specimens, actually give the following result:—

Pink Phase—Phenocrysts, 5 degrees; ground mass, 10 degrees.

Grey Phase—Phenocrysts, 9 degrees; ground mass, 15 degrees.

(?) *Hybrid*—Mostly 14 degrees; a few 9 degrees; some zoned.

The plagioclases in this rock, and particularly the more basic, frequently show corrosion, which suggests that they are xenocrysts from the Grey Phase.

This rock has, in addition, other features of special interest. The most remarkable of these is the abundance of primary pyrites, which occurs as individual crystals, sometimes of comparatively large size, and clusters of crystals scattered sporadically through the rock. Pyrites occurs, too, in the "vughs" to be described below. The pyrites is present in such amount and oxidises so rapidly on exposure to the air, producing dirty brown stains on the face of the rock, that the value of the rock as a building stone is very greatly lowered. Indeed it has of late been superseded by other granites brought from greater distances. In describing this rock Professor Richards states:

—"The occurrence of crystals of pyrites throughout the rock, and of cavities or 'vughs' containing calcite pyrites, &c., is a great disadvantage to this stone."[11].

These "vughs" or "druses" are peculiar to this rock and this particular outcrop, the writer never having observed them anywhere else in the area. They are of various size and occur in perfectly fresh rocks, having been found in the heart of the building-stone quarries. The minerals associated with these vughs are mostly calcite and pyrites, though quartz and prehnite are also found. These minerals are certainly not secondary in the sense that they are weathering products, but they are probably primary in origin and result from the action of mineralisers at a late stage of consolidation. They would thus be secondary only in the sense that many of the zeolites of the Tertiary basalts of Queensland are secondary. To use Sederholm's term, they are "deuteric."[11a]

Professor Richards points out that "a noteworthy feature of the stone is the comparative absence of segregations."[12] The present writer discovered small patches of fine-grained more-basic material which he at first regarded as segregations, but which microsections proved to be small zenoliths of the Grey Phase. A comparison of Plate II. No. 6 (a zenolith) with No. 5, which is described in the writer's field notes as "typical of the Grey Phase in the west and north-west of the Enoggera area," gives some idea of the close resemblance which is seen between these rocks when placed side by side on the stage of a petrographical microscope.

Of especial interest is the occurrence in both slides of rounded crystals of quartz, free from inclusions and surrounded by a rim of idiomorphic crystals of biotite arranged parallel to the outline of the quartz.

Towards the edges of the (?) Hybrid mass one finds irregular and vaguely defined patches of pink material of varying size. This zone forms in the field a connecting link between the Enoggera (?) Hybrid and the Pink Phase.

(*d*) The Rhyolitic Intrusives.

The intrusive rocks surrounding and associated with the granitic rocks fall naturally into two distinct types,

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[11] Op. cit. p. 102.

[11a] Bull. de la Comm. Geol. de Finlande No. 48, 1916, p. 142.

[12] Op. cit. p. 102.

although an occasional dyke is seen which has some points in common with each of these types. The types the author considered in Part I. of this paper under the headings "The Rhyolitic Intrusives" and "The Porphyries." More recently Mr. L. C. Ball, B.A., in his report dealing with the geology of the silver-lead deposits near Indooroopilly, included both these groups under the term "Felsites."

With his "Notes on Indooroopilly"[13] Mr. L. C. Ball, Deputy Chief Government Geologist, publishes a map of the Indooroopilly area on a considerably larger scale than that which accompanies Part I. of this paper, and showing the network of outcrops which the Rhyolitic Series form in this area in much greater detail than was done by the author. The author would like here to digress from the purely petrological point of view to discuss a structural matter of some importance.

Although Mr. Ball states that "attempts to distinguish laccolites and sills among the dykes are not warranted on the exposures," the author finds in Mr. Ball's descriptions and map several points which appear to uphold his published opinion that the intrusions of the southern area are largely laccolitic, the present outcrops being partial exposures of irregular laccolites. The author never intended to convey the idea that these laccolites were of the ideal type, which rarely has been found in the field. The closest approach to this ideal are the laccolites described by Gilbert from the Henry Mountains, Utah.[14] Gilbert himself, however, figures as an "ideal cross section of a laccolith with accompanying sheets and dykes," a series of intrusions which, on partial exposure by weathering, might very well give a quite similar outcrop to that in the neighbourhood of Indooroopilly. But the types of laccolite most closely approached in the Indooroopilly area are, in the author's opinion, those of the El Late Mountains, Colorado, described by Cross, and the so-called "Cedar-tree" compound laccolite described by Holmes from the La Plata Mountains of Colorado.[15] A good example of the less regular type of laccolite, and one which the author has had the opportunity of studying in the field, is the Gabbro

[13] Qld. Govt. Min. Journal, vol. xxi. p. 266.

[14] Report on the Geology of the Henry Mts. 1879.

[15] Harker, "Natural History of Igneous Rocks," p. 66, fig. 10.

laccolite of the Cuillins, Isle of Skye, described and figured by Harker.[16]

A glance at Mr. Ball's map shows a network of outcrops which at first are difficult to reconcile with the conception of a laccolite. This network is not, however, the outcrop of vertical and steeply dipping dykes striking in every direction. It is the result of mapping more or less continuous intrusions generally with a slight dip in a hilly locality. Mr. Ball recognises this fact and writes:—"In many of the exposures the dyke walls dip at comparatively low angles. In fact, most of the mapped loops are in reality not due to branching of the dyke mass, but to partial covering by schist islands or inliers."[17]

Away from the effect of the intrusions the Brisbane schists strike N.N.W. and dip quite steeply to the E.N.E. In discussing the Brisbane schists in the locality in question, Mr. Ball states:—"The strata have been much disturbed, notwithstanding that steep dips are exceptional here about. Even on the flat arches there has been much crenulation and puckering."

The expression "flat arches" fits in precisely with the author's view as to the laccolitic origin of these low dips.

To quote Mr. Ball further:—"The brecciation of the schists along the faults on Finney's Hill is a puzzling feature. The structure is certainly not due to compressive forces. To explain it we must assume an arching of the strata above a plutonic or hypabyssal intrusion sufficient to cause a breaking-down of the beds under the tensile stresses induced. Alternatively these stresses may have been induced in the sedimentaries by a partial retrograde movement (a sucking back, as it were) of the molten magma." The author feels sure the great majority of geologists would favour the former as being the more probable hypothesis. The arching of the strata which Mr. Ball "must assume" is the arching which I firmly believe to exist.

We have, then, found all the essential features of irregular laccolitic intrusion, with the exception of the flat bases. No evidence is available either way on this point at

[16] "The Tertiary Ingeous Rocks of Skye," Mem. Geol. Surv. U.K. 1904, 85 *et seq.*, fig. 15.

[17] Op. cit. p. 266.

the present time, but future mining operations in the area may furnish data on this matter.

To return to a consideration of the Petrology of the Rhyolitic Intrusives. The naming of the fine-grained acid intrusives was a matter to which the author gave considerable attention. In spite of their definitely intrusive character and the fact that many of them have been considerably altered by the addition of secondary silica, they appear to be petrologically more closely related to the Rhyolites than to any other rock group. Mr. Ball, in referring to rocks of this series, uses the terms "felsite" and "felsitic," which certainly reflect the mode of occurrence better than the author's term "Rhyolite" unless one is careful to qualify it by the word intrusive, but the absence of felsitic textures in the rocks examined under the microscope and, further, the fact that they can be closely correlated with the intrusive "Rhyolites" (so-called by Andrews and Saint-Smith) of New England (*see* Table II.), has led the author to retain the term "Rhyolitic Intrusives."

(*D. 12*) 171.—Dyke near junction of creeks in Portion 681, Parish of Indooroopilly. (*See* Microphotograph Plate III., No. 9.)

Megascopic.—A fine-grained greyish rock showing very small yellowish-brown felspars and small patches of pyrites set in a fine-grained grey base. A vein of quartz from 1-2 mm. across is to be seen traversing the specimen.

Microscopic.—Very fine-grained holocrystalline rock, with small vaguely defined decomposed phenocrysts of felspar (orthoclase ?) set in a ground mass made up entirely of *Quartz* and *Orthoclase*. Only part of the former mineral seems to be primary, as there is considerable evidence of secondary silicification. Pyrites occurs as fresh individual crystals of very small size and as larger aggregates.

Name.—Intrusive Rhyolite.

(*D. 64*) 415.

This specimen is of particular interest from the economic point of view. It was obtained by Mr. L. C. Ball at a depth of 130 feet in the main vertical shaft of the Finney's Hill United Silver Mines Ltd., near Indooroopilly, and supports in a very decided manner his hypothesis that the silver-lead and other ores of this area are closely associated with rhyolitic ("felsitic") intrusions. (*See* Microphotograph Plate III., No. 10.)

Megascopic.—A fine-grained light-coloured rock evidently made up for the most part of felspathic material and quartz, and traversed by numerous veins of quartz. Part of the surface of the specimen is coated with galena, accompanied by well-shaped quartz crystals.

Microscopic.—In order to preserve the appearance of this specimen a slice was cut not through the metalliferous part, but from a chip of the rock within one centimetre of it. Curiously enough this section shows no trace whatever of any metals except a few very small crystals of pyrites. The rock is similar in all its essentials to that described above (*D. 12*), but has numerous quartz veins through it and clusters of crystals of secondary quartz.

Name.—Intrusive Rhyolite.

(*e*) The Porphyritic Series.

The members of this series are usually easily separated from those of the Rhyolitic Series, but as pointed out by the author in Part I. of this paper, one occasionally meets with dykes that appear to be intermediate between these. This is, of course, only to be expected, as the two series are almost certainly genetically related. The evidence as to the relative time of intrusion of the Rhyolitic and Porphyritic Series is, so far, not conclusive, but points to the latter series as being later than the former.

(*D. 7*) 166.

Dyke across West Ithaca Creek in eastern part of Portion 678, parish of Enoggera. (*See* Microphotograph Plate III., No. 11.)

Megascopic.—A white prophyryritic rock made up of rounded colourless phenocrysts of quartz (in which can be seen numerous inclusions of a white mineral), with smaller phenocrysts of a white felspar set in a fine-grained light-coloured ground mass.

Microscopic.—Holocrystalline, porphyritic, the proportion of phenocrysts to ground mass corresponds to the "dopatic fabric" of Iddings. The ground mass is finely microcrystalline, and made up almost entirely of quartz and felspar, often intergrown. *Quartz* occurs in two distinct generations. The phenocrysts of this mineral are all rounded and embayed. They vary from 2-5 mm. in diameter, are more or less fractured, bear signs of corrosion, and show very definite "reaction rims" just outside the crystals themselves. Comparatively large rounded inclusions (or cross-sections of very deep embayments) made up of quartz-felspar aggregates similar to that of the ground mass is a feature of these quartz phenocrysts. The felspar phenocrysts are considerably altered to muscovite and other micaceous products, with the result that some of them are indeterminate, but in some cases enough remains of the original minerals to show that both *Orthoclase* and *Plagioclase* are present. The latter shows traces of Albite twinning and appears, from measurements of extinction angles, to be an intermediate andesine. Zoning is fairly definite in some of these phenocrysts. Inclusions of apatite were observed. Ferro-magnesian minerals are but poorly developed, but fragments of *Biotite* largely altered into colourless secondary minerals and magnetite were observed. Magnetite occurs in irregular patches and idiomorphic crystals, and seems to be pseudomorphus after *Pyrites*, as some remnants of this mineral are present in the interior of the magnetite crystals. Further alteration has resulted in patches of Limonite. Other minerals present in small amount are *Apatite* and *Zircon*.

Name.—Quartz Porphyry (Granodiorite Porphyry).

(*D. 4*) 163.

Dyke on road, Constitution Hill, Taylor Range. (*See* Microphotograph Plate III., No. 12.)

Megascopic.—A holocrystalline porphyritic rock made up of numerous phenocrysts of brown felspars, showing zoning and fewer smaller phenocrysts of quartz and a dark ferro-magnesian mineral set in a fine brown ground mass.

Microscopic.—Rock very decomposed. Holocrystalline, porphyritic (sempatic fabric of Iddings). The ground mass is a very fine-grained confused aggregate of felspathic material, quartz, and secondary minerals, resulting from the alteration of the felspars. Small patches of limonite are scattered throughout the rock. The felspar phenocrysts, which vary from 2-7 mm. in length, occur in very altered crystals, and are really pseudomorphous aggregates of muscovite and other secondary minerals. In spite of this the felspars still show idiomorphic outlines, and zoning is still recognisable (indeed the zoning is apparent in the hand specimen), and points to the felspars as *Plagioclases,* although no more exact determination is possible. In some cases these phenocrysts partly enclose chloritic clusters, which are secondary after some ferro-magnesian mineral. *Quartz* occurs as a few phenocrysts up to 2 mm. in diameter, which are very similar to those described in (*D. 7*). The ferro-magnesian constituents are represented by patches of chloritic material.

Name.—Quartz Porphyry (Granodiorite Porphyry).

IV. COMPARISON WITH ROCKS OF OTHER AREAS.

(*a*) *New England and Stanthorpe*—

In Part I. of this paper the author pointed out that the granitic and allied rocks of the Enoggera district were closely comparable with those of New England in northern New South Wales, and the contiguous masses of the Stanthorpe district in the southern part of Queensland. The age of these great intrusions was seen to be much about the same, *i.e.,* very late Palæozoic; structurally they followed the same trends, while mineralogically they were very similar.

Even more striking resemblances are discovered if the sequence of events in the different areas be compared. Table II. has been drawn up for this purpose. The order of intrusion in the New England district is that found by Andrews, while in the adjacent Stanthorpe area the sequence adopted is that of Saint-Smith. These two areas are practically continuous, so that they can be very definitely correlated. If these two columns be compared it will be found that, although the grouping and naming differ somewhat, the rock types and their order of intrusion are identical, with but one exception. The "Sphene" granite is considered by Andrews to be definitely earlier than the

"Acid" granite, and probably earlier than the "Basic Granites," while Saint-Smith thinks it is much more closely related to the "Stanthorpe" (Acid) granite, and, indeed "may possibly be a modification of the 'Stanthorpe' granite."[18] The Enoggera sequence shown in the third column agrees more closely with Andrews's interpretation on this point, but otherwise the local sequence is remarkably close to both the New England and Stanthorpe records.

TABLE II.

New England (Andrews)[19].	Stanthorpe (Saint-Smith)[20]	Enoggera (Bryan).
Intermediate to basic dykes	Basic dykes often associated with Au., Ag., Pb. Zn., Cu.	..
Rhyolites, Q. porphyries, porphyries	Rhyolites, Q. porphyries, porphyries, also	Rhyolites with Ag., Pb., Zn., Q. porphyries, porphyries
"The Euritic Period" ..	Aplites, greisens and pegmatites; sandy granite with Sn. Wo., and Mo.	Aplites with little Mo, granophyres and pegmatites
"Coarse acid granites" ..	Coarse acid "Stanthorpe granite closely associated with porphyritic sphene granite	Pink phase proper (= Mountain Camp quartz mica diorite)
"Hornblendic, dioritic, and other basic granites"	Maryland adamellite (= Greymare granite)	Grey phase
"Blue granite"	"Blue granite"	..
"Blue and black porphyries"	..	..
"Grey felspar porphyry" ..	"Acid grey felspar porphyry"	..
	Altered dioritic rocks ..	..

Note.—The "sphene-diorite porphyry" of Andrews and the "porphyritic sphen granite" of Saint-Smith are one and the same rock. The difference in position reflect a difference of opinion of these authors.

Although the Pink Phase, the Aplitic, and the Rhyolitic and Porphyritic Intrusives had their obvious counterparts in the Stanthorpe and New England Series, the "Grey Phase" was not so easily placed, and the author did not (in the earlier part of this work) care to venture an opinion as to the precise position it occupied in these series. Since the publication of Part I., definite evidence

[18] Op. Cit., p. 18.

[19] "New England Geology" Part IV. Petrology. Rec. Geol. Surv. N.S.W., Vol. VIII. pt. 3, p. 196 *et. seq.*

[20] "Geology and Mineral Resources of the Stanthorpe, Ballandean, and Wallangarra Districts." Qld. Geol. Surv. Pub. No. 243.

of a chemical nature has become available as the result of analyses of the "Grey Phase" and the Greymare rock. The first of these (E4) was found to resemble certain analyses of the "basic granites" very closely, and did not resemble those of any other of the Phases.

Of these "basic granites," Andrews writes:—"Striking dissimilarities in appearance is a marked feature."[21] The analyses which accompany his descriptions emphasise this feature. Of the four quoted, two are comparatively acid and have alkalies in moderate amount, the K_2O being in excess of the Na_2O. These obviously have little in common with the "Grey Phase." They seem, indeed, to be more closely related to the coarse-acid granite that immediately followed them, for Andrews remarks that the more-basic types were somewhat earlier and the remaining two analyses are of this earlier more-basic type. They are of very different rock types from the others, and possess the essential characteristics of the Grey Phase, as can be seen by their positions (N.7 and N.8) on the variation diagrams.

No analysis exists as yet of the "Maryland" granite, which, however, is considered by Mr. Card[22] to be an Adamellite. It is "a fine to medium-grained greyish-blue rock." Saint-Smith,[23] in his chapter on the "Maryland" granite refers to one other rock which he says "resembles the Maryland granite to such a marked degree in hand-specimens that it may ultimately prove to represent an outcrop of this rock." This is the "Greymare" granite which has since been analysed (S.4.) This analysis, while considerably more acid, resembles those of the "Grey Phase" on the one hand and "Basic Granites" on the other in several important particulars, particularly in the preponderance of Na_2O over K_2O.

The Grey Phase seems then to be connected indirectly (through the Greymare granites) with the Maryland Adamellite and directly with the "Basic Granites" of New England.

If chemical tests be applied it will be found that the results confirm very strongly the above correlations.

[21] Op. Cit., p. 212.

[22] Min. Res. N.S.W. No. 14, p. 91.

[23] Op. Cit., p. 61.

Variation diagrams, Plate I., Figures 1 and 2, have been carefully prepared, which show a very definite chemical relationship between the "Pink Phase" and "Acid" granites on the one hand, and the "Gray Phase" and "Basic" granites on the other.

If reference be made to Figure 1, in which the percentage weights of K_2O and Na_2O have been plotted against that of SiO_2, it will be noticed that the "Grey Phase" of the Enoggera granite (E.4) is connected with the "Greymare" granite (S.4) on the one hand and the "Basic Granites" of New England (N.7 and N.8) on the other by variation lines which show that Na_2O is present in considerable excess of K_2O in each case. While at first glance these lines seem parallel, a closer inspection shows that there is a gradual convergence as one proceeds from the more basic to the more acid rocks. In other words, the ratio $Na_2O : K_2O$ varies inversely with the acidity. The Ballandean granite (S.3) has been linked up with these curves for obvious reasons, although Saint-Smith refers to the specimen from which the analysis was made as one type of the "Stanthorpe" granite—"a medium-grained variety from Ballandean."[24]

If these "curves" be compared with the corresponding curves joining the "Pink Phase" and the "Stanthorpe" and "Sandy" granites, some very decided differences will be observed. A very close approximation in the values of K_2O and Na_2O is apparent, the curves for these oxides interweaving and remaining close together. One would naturally expect that the "Acid" granites and "Eurites" of New England, which have been so definitely correlated with the "Stanthorpe" and "Sandy" granites respectively, would approach them so closely in chemical composition as to be readily reconciled to one variation curve for the two series. In the K_2O and Na_2O values such is not the case. The K_2O is somewhat higher in the New England rocks and the Na_2O correspondingly lower. Consequently the ratio $K_2O : Na_2O$ is very much greater than in the Stanthorpe rocks. Curiously enough, in the chain of chemical evidence connecting the Pink Phase, the acid Stanthorpe granites, and the acid granites of New England, the latter is the weaker link in spite of the fact that the former connects outcrops which are separated by approximately 100 miles.

[24] Op. Cit., p. 43.

The values of the alkalies of these New England rocks have, then, been linked up to form curves independent of the main "Pink Phase"—"Stanthorpe" curve.

Three analyses are shown in which the K_2O and Na_2O values do not readily fall on either curve. These are the "Acid" granites from Tingha, New South Wales (N.2), the "Sandy" granite of Stanthorpe (S.1), and the Enoggera Hybrid. It may be argued that any attempt to fit this "Sandy" granite into the variation diagrams was unwarranted in the first place, as it represents a later phase than the "Acid" granite. However, these two acid phases are very closely associated in the field, and the position of the New England "Euritic" granite (N.4) on the diagram partly justifies the assumption of their close relationship. However, if both the Sandy and Euritic granite be ignored there remains one rock (N.2) in a somewhat anomalous position.

In Figure 2 the values of CaO and MgO have been plotted in the same manner as the alkalies in Figure 1. In this case the same sets of curves have been drawn, but the natural grouping along three different sets is not nearly so well displayed. Indeed, one might draw one set of generalised curves to which all the values plotted might be referred.

In both figures it will be noted that the values for the Enoggera (?) Hybrid do not fall on either curve. Any attempt to include them with the Pink Phase or the Grey Phase will seriously derange either curve.

TABLE III.

THE PINK PHASE AND THE EQUIVALENT ROCKS IN STANTHORPE AND NEW ENGLAND.

—	E. 1.	S. 1.	S. 2.	S. 5.	N. 1.	N. 2.	N. 3.	N. 5.	N. 6.
SiO_2	73·52	77·15	76·19	67·24	78·14	76·28	75·78	73·98	71·27
Al_2O_3	11·05	13·45	11·53	14·20	11·89	11·41	12·42	13·47	13·40
Fe_2O_3	Nil	0·40	0·84	1·50	0·60	1·60	0·55	0·72	1·11
FeO	3·15	1·26	1·25	2·88	0·27	0·72	1·08	0·97	1·89
MgO	1·03	0·72	0·60	1·39	0·15	0·15	0·50	0·36	0·79
CaO	1·70	1·22	1·14	3·24	0·44	0·62	1·06	0·90	2·46
Na_2O	4·08	2·72	3·80	3·98	3·51	3·97	3·20	3·39	3·08
K_2O	3·99	3·76	4·14	4·07	4·62	4·54	4·60	4·88	4·91
H_2O + ...	0·44	0·20	0·28	0·50	0·32	0·40	0·44	0·32	0·32
H_2O −	0·16	0·08	Nil	0·12	0·28	0·16	0·14	0·12	0·18
CO_2	n.d.	..	..	0·06	..	..	0·01	0·04	0·03
TiO_2	0·20	..	0·09	0·65	0·06	0·20	0·29	0·54	0·24
P_2O_5	0·15	0·10	0·25	0·11	0·02	0·17	0·10	0·05	0·10
MnO	n.d.	0·32	0·16	0·06	..	..	0·07	0·03	..
Etc.	..	..	..	0·07	..	..	0·11	0·06	..
Total	99·47	101·38	100·27	100·07	..	..	100·35	99·83	..
Sp. Gr.	2·58	..	..	2·711	..	..	2·626	2·030	..
Symbol	I. 3.1.3 (4)	I. 4.2.3	I. 3(4).1.3	II. 4.2.3 (4)	I. 3(4).1.3	I. 3(4).1.3	I. 3.2.3	I. 3.1.3	I. 4.2.3
Name	Alaskose	Toscanose	Alaskose	Adamellose	Alaskose	Alaskose	Tehamose	Alaskose	Toscanose

TABLE IV.

THE GREY PHASE AND THE EQUIVALENT ROCKS IN STANTHORPE AND NEW ENGLAND.

	E. 4.	S. 3.	S. 4.	N. 7.	N. 8.
SiO_2	61·10	74·89	69·70	55·05	50·04
Al_2O_3	19·24	15·11	17·70	14·15	18·68
Fe_2O_3	} 4·66 {	1·06	1·94	1·80	0·80
FeO		2·26	1·40	5·31	6·91
MgO	2·56	0·82	1·19	8·07	7·79
CaO	5·25	1·67	2·29	9·36	9·88
Na_2O	3·82	2·06	3·12	2·82	2·35
K_2O	1·68	0·73	1·36	0·72	0·12
H_2O +	1·31	0·50	0·47	1·46	1·74
H_2O −	0·64	0·31	0·25	0·22	0·28
CO_2	..	..	Nil	0·02	0·27
TiO_2	Det. with Al_2O_3	..	0·19	0·57	0·80
P_2O_5	..	0·27	tr.	0·06	0·16
MnO	..	0·22	tr.	0·22	0·14
Etc.	..	..	..	0·06	0·62
Total	100·26	99·90	99·61	99·89	100·58
Sp. Gr.	2·71	..	2·66	2·814	2·977
Symbol	II. 4.3.4	I. 2.2.4	I. 3.3(2).4	III. 5.3.4	III. 5.4.3
Name	Tonalose	..	Near Alsbachose	Camptonose	Auvergnose

TABLE V.

ANALYSES USED IN TABLES III. AND IV. AND PLATE I, FIGURES 1 AND 2.

No.	Type.	Locality.	Reference.	Analyst.	Laboratory.
N. 1	Acid	Butchart's Reef, Tingha, New England	Ann. Rpt. Dept. Mines, N.S.W., 1907, p. 185	Not stated ..	Department of Mines, N.S.W.
N. 2	Acid	Middle Creek, Tingha, New England ..	Min. Res. N.S.W., No. 14, p. 63	H. P. White ..	Department of Mines N.S.W.
N. 3	Acid average ..	Bolivia, New England	Rec. Geol. Surv. N.S.W., vol. viii., pt. 3, p. 220	J. C. H. Mingaye	Department of Mines, N.S.W.
N. 4	Euritic	Two miles east of Tenterfield, New England	Rec. Geol. Surv., N.S.W., vol. viii., pt 3, p. 225	J. C. H. Mingaye	Department of Mines, N.S.W.
N. 5	Acid	21-mile peg, Deepwater to Bolivia, New England	Rec. Geol. Surv., N.S.W., vol. viii, pt. 3, p. 220	J. C. H. Mingaye	Department of Mines, N.S.W.
N. 6	Tingha	Tingha, New England	Min. Res., N.S.W., No. 14, p. 64	W. A. Grieg ..	Department of Mines N.S.W.
N. 7	Diorite	Near Junction Baker's Creek, Hillgrove, New England	Rec. Geol. Surv., N.S.W., vol. viii, pt. 3, p. 214	J. C. H. Mingaye	Department of Mines, N.S.W.
N. 8	Diorite	Near Murgatroyd's Tunnel, Hillgrove, New England	Rec. Geol. Surv., N.S.W., vol. viii, pt. 3, p. 216	J. C. H. Mingaye	Department of Mines, N.S.W.
S. 1	Sandy	Stanthorpe, Southern Queensland ..	Qld. Geol. Surv. Pub. 243* p. 38 ..	G. R. Patten ..	Queensland Agricultural Department.
S. 2	Stanthorpe ..	Quarry, near Stanthorpe, Southern Queensland	Qld. Geol. Surv. Pub. 243, p. 43 ..	G. R. Patten ..	Queensland Agricultural Department.
S. 3	Stanthorpe ..	Ballandean, Southern Queensland ..	Qld. Geol. Surv. Pub. 243, p. 43 ..	G. R. Patten ..	Queensland Agricultural Department
S. 4	Greymare ..	Greymare, near Warwick, Southern Queensland	Proc. Roy. Soc. Qld., vol. xxx, p. 150 ..	Miss I. Sterne ..	Geological Department, University of Queensland
S. 5	Stanthorpe ..	Amosfield, near Stanthorpe, Southern Queensland	Min. Res., N.S.W., No. 14, p. 84 ..	H. P. White ..	Department of Mines, N.S.W.
E. 1	Pink Phase ..	Portion 823-824, parish of Enoggera, near Brisbane	Ann. Rep. Ag. Chem. Qld., 1915, p 20 ..	G. R. Patten ..	Queensland Agricultural Department
E. 2	Hybrid ..	Quarry, Enoggera Creek, near Brisbane..	Proc. Roy. Soc. Q d., vol. xxx, p. 150 ..	N. H. Christensen	Queensland Agricultural Department
E. 3	Pink Phase ..	Quarry, Mountain Camp, near Brisbane..	Now first published	G. R. Patten ..	Queensland Agricultural Department
E. 4	Grey Phase ..	Included mass in Pink Phase, Enoggera, near Brisbane	Now first published	Miss E. W. Muir..	Geological Department, University of Queensland

* This analysis has evidently been confused with that on page 43 (S. 2). The correct analysis appears under S. 1.

(b) OTHER QUEENSLAND AREAS.

The division of the granitic rocks of the Enoggera district into two phases—the earlier typically granodioritic (the Grey Phase) and the later somewhat more alkaline (the Pink Phase)—seems to be reflected in all those granitic rocks of Queensland of which analyses are available. Not only is this twofold development widespread geographically; in time, too, it appears to be wonderfully persistent. As far north as Charters Towers and as far back as Early Devonian, these two distinct phases are met with.

The plutonic rock nearest to the Enoggera area, of which a chemical analysis exists, is the Mountain Camp Quartz Mica Hornblende Diorite, which lies within 3 or 4 miles of the main Enoggera outcrop (*see* analysis E.3). This rock has a handsome appearance and makes an excellent building stone. It was selected by Professor H. C. Richards as the most suitable granitic rock available for the construction of the base of the new Brisbane Town Hall. Mineralogically this rock most closely resembles the Pink Phase, although it is, of course, considerably less acid and does not carry enough pink orthoclase to give the characteristic colour. The chemical analysis gives added weight to the mineralogical evidence, for though it is remarkably like that of the Grey Phase (E.4) in most respects, in the all-important matter of the alkalies it shows its true relationship to the Pink Phase, the Na_2O being slightly in excess of the K_2O. The variation diagrams, too, point clearly to its relationship to the Pink Phase.

The remaining comparisons must necessarily be general in their nature. So little has been done in the study of the plutonic rocks of Queensland that little in the way of detailed correlation is possible.

Mr. Reid[25] has described from the Charters Towers goldfield a series of granodiorites and associated rocks of Lower Devonian or pre-Devonian age, all of which show rather low alkalies with a decided excess of Na_2O over K_2O, and which are followed by an aplitic granite which "is intrusive in the granodiorite" and the analysis of which shows high alkalies with the potash in excess of the soda.

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[25] "The Charters Towers Goldfield," Qld. Geol. Surv. Pub. No. 256, p. 66.

This seems to have been followed by a reversion to a series of dykes of a dioritic and porphyritic nature, all of which show a preponderance of Na_2O over K_2O with comparatively high values for CaO.

In the East Moreton and Wide Bay districts to the north of the Enoggera area are a number of plutonic and hypabyssal rocks which have been described by Dr. H. I. Jensen,[26] and which petrologically and chemically seem to have many points in common with the Enoggera rocks. Of these the "Neurum" granite of the Woodford area seems to most nearly approach the Enoggera granites in age, since Jensen considers it to be "post-Carboniferous, probably Permian."[27] It is described as "a bluish, tonalitic granite." Referring to this granite he says further:—"The graphic granite aplites of the Delaney's Creek and Fife's Range mountains are probably the last differentiation products of this mass." This seems a fairly close parallel both of types and events with the Enoggera area.

Further, Jensen, in summarising the history of this East Moreton and Wide Bay area, refers to an original quartz dioritic rock which was closely followed by an aplitic phase, one result being the formation of "mixed" rocks referred to earlier in this paper.

V. ECONOMIC.

The decision at which the author arrived, that the Enoggera granite was probably related to the Stanthorpe and New England "acid" granites, held an economic interest in addition to its geological significance, as both these granites are stanniferous. However, so far as the author can discover, no find of tin has ever been made on this area. As noted on p. 152, Part I., of this paper, flakes of molybdenite were discovered while the field work was being carried out, and since that time molybdenite in small quantities has been found in several parts of the area.

This sparse occurrence of molybdenite and the local tourmalinisation of the granite on its north-eastern edge are the only points which suggest the possible existence of tin

[26] "Geology of Parts of the East Moreton and Wide Bay Districts. Proc. Linn. Soc. N.S.W. Part I. 1906, p. 73.

[27] Op. Cit., p. 92.

within this area, although mining for arsenic, gold, silver, copper, lead, and bismuth[28] has been carried out at the neighbouring Samford massif some few miles away.

On p. 161, Part I., Rands was quoted as having described "very minute specks of gold" in one of the dykes which form the extensive system of intrusions between the south-eastern edge of the Enoggera granite and the Brisbane River at Indooroopilly. Up to that time (November, 1914) no other minerals of economic value had been found associated with these intrusions, but in the year 1918, a discovery of silver-bearing galena was made at Finney's Hill, near Indooroopilly, associated with the "Rhyolitic" intrusions. Up to the present some 280 tons of lead and 45,753 oz. of silver have been produced from the area, while the presence of copper, zinc, and bismuth in smaller amounts has been proved. Ball has mapped the intrusives in this area in great detail, as he considers them the "sole guides in searching for new shoots of ore."[29] He states further that "a clear case is presented at Indooroopilly in favour of a magmatic derivation, the metalliferous solutions being an extreme differentiate of the plutonic igneous mass from which the felsitic dyke rocks arose—the presence of $\frac{1}{4}$ to $\frac{1}{2}$ per cent. bismuth is, in my opinion, decisive evidence."

A specimen of the rhyolite ("felsite"), which actually contained silver-bearing galena, was kindly supplied by Mr. Ball, sliced and microphotographed. (*See* Plate III., No. 8.) The rock is in all respects like the other intrusive rhyolites of the neighbourhood, except that veins of secondary quartz are even more pronounced than usual.

The value of the Hybrid rock (commercially known as the "Enoggera Granite") as a building stone, and for purposes of "pitching," "kerbing," and road-making has been very fully dealt with by Professor Richards in a paper read before this Society in July, 1918.[30]

CONCLUSION.

In conclusion, I wish to thank Professor H. C. Richards, D.Sc., for the interest he has shown in this work (which was originated at his suggestion) and for his helpful advice on many points.

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[28] L. C. Ball, Qld. Govt. Min. Journ., Vol. XXI. p. 266.

[29] L. C. Ball, Qld. Govt. Min. Journ., Vol. XXI. p. 267.

[30] "The Building Stones of Queensland," Proc. Roy. Soc. Vol. xxx., p. 101 *èt seq.*

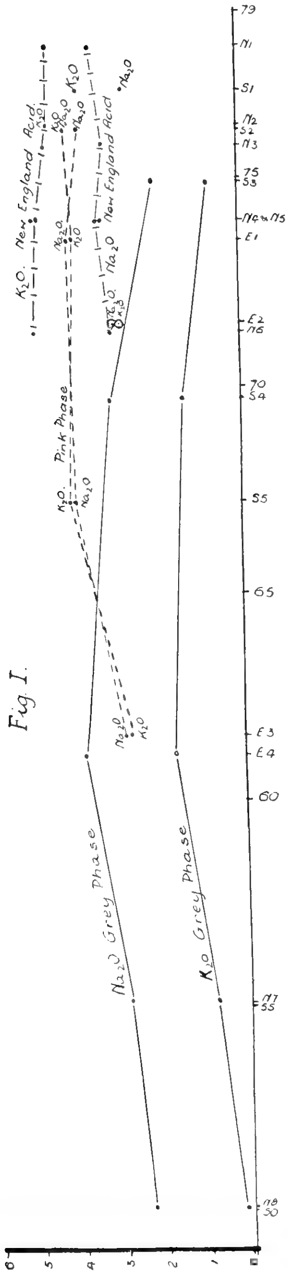


Fig. I.
K2O. New England Acid.
Na2O New England Acid
Pink Phase
Na2O Grey Phase
K2O Grey Phase

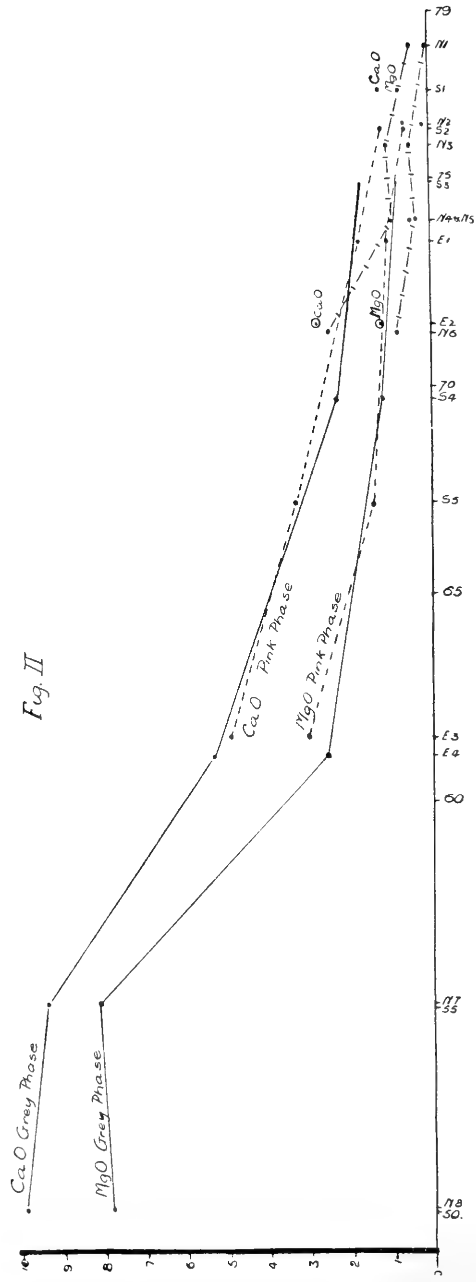
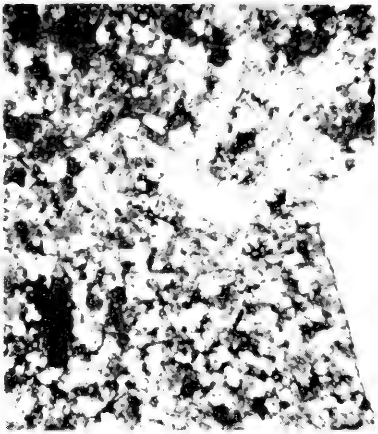


Fig. II
CaO Pink Phase
MgO Pink Phase
CaO Grey Phase
MgO Grey Phase



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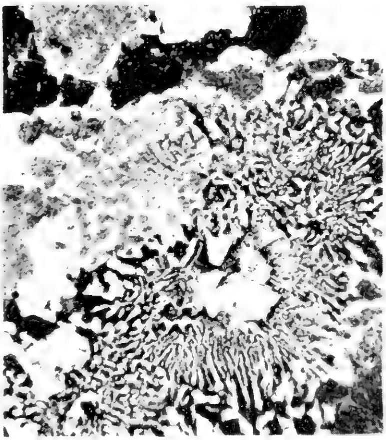

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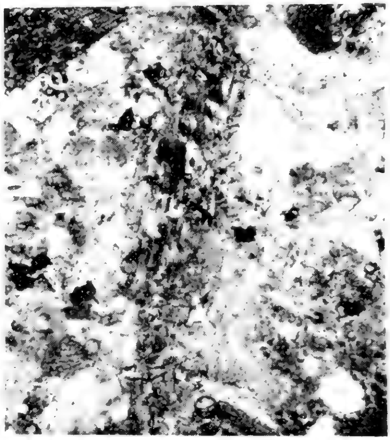


4.

5.

6.

Plate I.

VARIATION DIAGRAMS.

These have been constructed by plotting the silica percentage (on the horizontal axis) against the other oxides in percentages (on the vertical axis). The scales are the same for each axis and for each figure.

Lines joining members of the Grey Phase are shown thus:————

Lines joining members of the Pink Phase are shown thus:- - - - - - - -

Lines joining members of the New England Area are shown thus:—|—|—|—|—|

The position of the Enoggera Hydrid is shown thus :⊜

The letter-numbers (E.1, S.3, N.4, &c.) refer to the analyses of Tables III., IV., and V.

Figure 1 shows the curves obtained by plotting K_2O and Na_2O against SiO_2.

Figure 2 shows the curves obtained by plotting CaO and MgO against SiO_2.

Plates II. and III.

MICROPHOTOGRAPHS.

All the microphotographs are magnified 25 diameters. No. 4, Plate II., was taken in ordinary light. All the other microphotographs were taken with crossed nicols.

Plate II.

No. 1 (G.1) 141.—Pink Phase. Specimen from southern part of main Enoggera mass, × 25, crossed nicols.

No. 2 (G.26) 422.—Pink Phase. Specimens from Green Hill area, × 25, crossed nicols.

No. 3 (G.43) 351.—Micrographic structure in Aplite, × 25, crossed nicols.

No. 4 (G.44) 416.—Grey Phase. Hornblendic type. Portion 374, parish of Enoggera, × 25, ordinary light.

No. 5 (G.41) 345.—Grey Phase. Intermediate between Hornblendic type (*see* No. 4) and Biotitic type (*see* No. 6). From near "The Summit," Taylor Range, × 25, crossed nicols.

No. 6 (G.14) 418.—Grey Phase. Biotitic type from western part of the main Enoggera area, × 25, crossed nicols.

PLATE III.

No. 7 (G.6) 154.—(?) Hybrid Granodiorite from Quarry, Enoggera Creek, × 25, crossed nicols.

No. 8 (G.6) 154.—Zenolith of Biotitic type of Grey Phase in (?) Hybrid. Compare with Plate II., No. 6, × 25, crossed nicols.

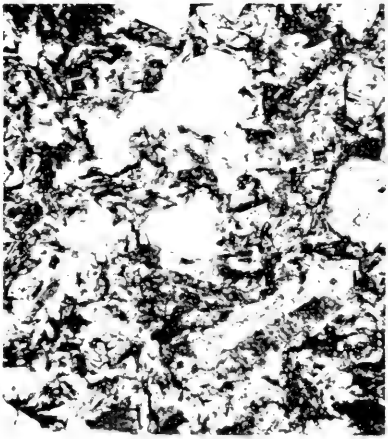
No. 9 (D.12) 171.—Intrusive Rhyolite near junction of creeks in portion 681, parish of Indooroopilly, × 25, crossed nicols.

No. 10 (D.64) 415.—Intrusive Rhyolite associated with silver-lead ores, Indooroopilly, × 25, crossed nicols.

No. 11 (D.7) 166.—Porphyritic dyke across west Ithaca Creek, × 25, crossed nicols.

No. 12 (D.4) 163.—Porphyritic dyke on road, Constitution Hill, Taylor Range, × 25, crossed nicols.

7.



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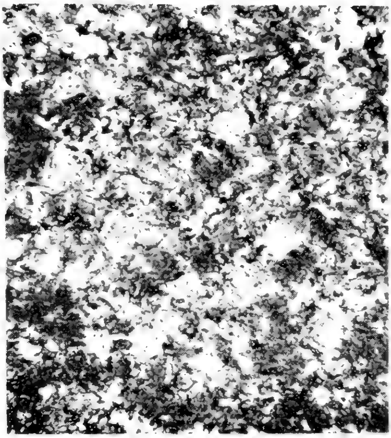

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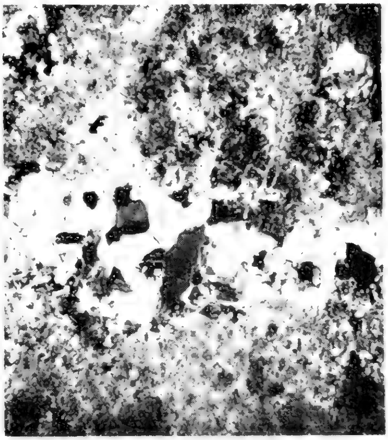
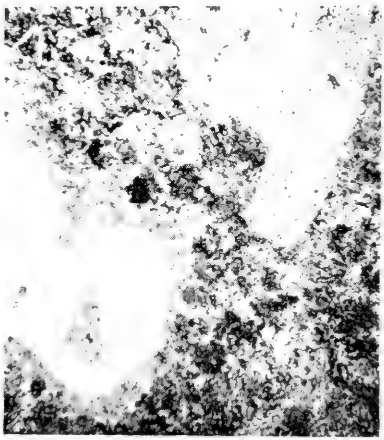


10.

11.



12.

Anorthoclase Basalt from Mapleton, Blackall Range, South-Eastern Queensland.

By H. C. Richards, D.Sc., Professor of Geology and Mineralogy, University of Queensland.

(Plate IV.)

(*Read before the Royal Society of Queensland, 31st August, 1922.*)

Some time ago, while investigating the volcanic rocks of the Blackall Range some 60 or 70 miles north of Brisbane, in the Mapleton area, the author was attracted by a basaltic flow which contained numerous lozenge-shaped phenocrysts of felspar. Subsequent microscopic examination bore out the prediction that they were crystals of anorthoclase felspar.

Mr. G. J. Saunders, B.E., M.Sc., who was completing his honours course in Geology at the University in 1918, kindly undertook the complete chemical analysis of the rock; and an inspection of this shows the presence of 7·02 per cent. of alkalies—an excess of nearly 3 per cent. over the combined alkalies in the average analysis of basalt as given by Daly.[1]

Although many rhyolitic and trachytic rocks with very decided alkaline characters have been described from Southern and Central Queensland by Dr. H. I. Jensen and the author, up to the present there has not been any record of a sub-basic or basic alkaline rock containing anorthoclase.

This paper, therefore, constitutes the first record in Queensland of a basic alkaline lava containing anorthoclase.

FIELD OCCURRENCE.

About 2 miles to the south-west of the township of Mapleton, in the proximity of the Mapleton Falls, where the road leaves the top of the range to descend into the

[1] R. A. Daly, "Origin of Igneous Rocks."

valley, one finds the flow in question outcropping on the road and in the paddocks on either side. The extent of the outcrop has not been determined, but it covers a considerable acreage, while the thickness is probably something more than 20 feet.

The flow forms one of the most recent of a large number which rest approximately horizontally upon the denuded surface of the Bundamba Sandstones of Upper Triassic age, and in all probability the flow was poured out in Upper Kainozoic times.

About one-half mile nearer to Mapleton than this anorthoclase basalt one finds rhyolitic rocks outcropping in a very weathered condition. In other parts of the Blackall Range, *e.g.*, near Montville and Flaxton, the upper basalts have been poured out over the rhyolite, and this is probably the relation of the different rocks at Mapleton. Immediately underlying the anorthoclase basalt flow is a considerable thickness of olivine basalt, which is well shown in the section over which passes the water at Baroon or Mapleton Falls.

The height above sea-level is approximately 1,400 feet, and both to the south and west the range falls away steeply.

Generally speaking the basalts of the Blackall Range are very much weathered, and considerable depths of soil are accumulated on the surface. This rock yields a very rich red soil, and the weathered surface has a distinctive dark-brown colour which serves as a useful indication of its weathered outcrop.

In collecting specimens, the extreme toughness of the rock is evident and in marked contrast to most of the basalts of the area. For purposes of road construction this toughness should result in a resistance to abrasion superior to that of the other basalts in the neighbourhood, and as such it has a special value.

MEGASCOPIC CHARACTERS.

In general grain-size and colour the basalt is quite normal, but the presence of numerous phenocrysts of more or less lozenge-shaped anorthoclase felspars is a characteristic feature. An occasional phenocryst, lath-shaped and showing lamellar twinning, is seen, but anorthoclase much predominates.

The cleavage surfaces of the latter show an interference in the reflection, owing to the abundant inclusions of augite and magnetite, which are seen to better effect under the microscope.

The specific gravity is 2·725 and is rather lower than usual in the basalts of this area.

MICROSCOPIC CHARACTERS.

SECTION NO. 266.[2]

The rock is holocrystalline, with phenocrysts of anorthoclase up to 5 mm. in length.

The ground-mass is composed of plagioclase laths up to 0·35 mm. long, augite granules averaging 0·1 mm. in diameter, and abundant small octahedral crystals of magnetite about ·03 mm. in diameter.

The fabric is porphyritic and perpatic.[3] The minerals present are anorthoclase as phenocrysts, plagioclase (acid andesine to medium andesine), augite, olivine, magnetite, and a greenish alteration product.

The anorthoclase phenocrysts, like many of the phenocrysts of plagioclase in the basalts and andesites of Upper Kainozoic age in Southern Queensland, have been much affected by the ground-mass, as the corners are rounded and a definite reaction rim has developed.

The abundance of augite and magnetite inclusions in these anorthoclase phenocrysts is a marked feature. In all cases the reaction rim is free from inclusions. (*See* Fig. 1, Plate IV.)

A definite net-like arrangement of considerable regularity characterises the inclusions, and many instances suggesting micrographic intergrowth of the augite "inclusions" and the phenocryst may be seen.

Simple twinning is common in the crystals, and in one or two cases very fine microcline twinning occurs.

The plagioclase crystals in the ground-mass furnish lath-shaped and rectangular sections.

[2] The number refers to the slide in the University of Queensland collection.

[3] J. P. Iddings, "Igneous Rocks," Vol. I., 1909, p. 199.

From the extinction angles the felspar varies from acid to medium andesine.

The augite is highly titaniferous, as it has a distinct violet tinge. The habit of the crystals varies. It may be in compact granules showing ophitic structure with the plagioclase and containing inclusions of magnetite, or else it may occur as long narrow wisps up to 1·75 mm. but still showing ophitic structure.

The most interesting occurrence of augite, however, is in the form of inclusions in the anorthoclase phenocrysts when several granules in close proximity are optically continuous, and in this way micrographic intergrowth of the felspar and augite is indicated.

Olivine in the form of clear rounded granules occurs abundantly, and it is usually associated with a greenish alteration product—possibly serpentine.

Magnetite in small octahedral crystals occurs abundantly throughout the ground-mass and as inclusions in the phenocrysts and in the augite granules.

CHEMICAL CHARACTERS.

For the purposes of comparison four other analyses are given in addition to that of the anorthoclase basalt.

The second one—that of a flow of oligoclase basalt from the summit of Spicer's Peak in the Main Range, near Cunningham's Gap—bears a striking similarity to the analysis under consideration.

The third analysis of an olivine basalt from Mount Lindsay is also of interest for comparison.

The fourth analysis carried out by Miss Rose Scott, M.Sc., in 1918, indicates the chemical character of the normal basalt which occurs along the top of the Blackall Range.

The fifth analysis is that given by R. A. Daly as the average analysis of a basalt.

It will be noted that the anorthoclase basalt has lower alumina, more iron oxides, less magnesia, considerably less lime, more soda, and twice as much potash as the ordinary sub-alkaline basalt from Montville, which is characteristic of the Blackall Range as a whole.

In comparison with the average basalt analysis, the marked deficiencies in magnesia and lime and equally marked excesses of soda and potash are the outstanding features of the anorthoclase basalt.

An examination of the norms shows a very close resemblance, especially in the felspathic content of the Mapleton and Spicer's Peak basalts. The modes of the two rocks differ considerably, also there is much difference in their textures and crystallinity.

The felspathic content of the norm of the Montville basalt is in sharp contrast with that of the Mapleton basalt. The deficiency in potash and the excess in lime of the former is made very pronounced.

CHEMICAL ANALYSES.

Rock.	Anorthoclase Basalt. Mapelton.	Oligoclase, Basalt. Spicer's Peak.	Basalt. Mount Lindsay.[4]	Basalt. Montville.	Average Basalt (R. A. Daly.)
Analyst	G. J. Saunders, B.E., M.Sc.	G. R. Patten.	G. R. Patten.	Rose Scott, M.Sc.	
SiO_2 ..	53·33	52·95	47·50	52·00	49·06
Al_2O_3 ..	14·57	15·56	14·19	18·76	15·70
Fe_2O_3 ..	4·47	2·62	1·78	1·86	5·38
FeO ..	6·67	7·29	12·15	5·84	6·37
MgO ..	3·24	2·89	5·06	4·15	6·17
CaO ..	5·76	4·92	7·47	7·31	8·95
Na_2O ..	4·40	4·46	3·85	3·75	3·11
K_2O ..	2·62	2·94	1·58	1·27	1·52
H_2O + ..	2·09	2·18	1·59	1·06	} 1·62
H_2O − ..	0·98	0·75	0·33	0·80	
TiO_2 ..	1·71	1·84	3·08	1·85	1·36
P_2O_5 ..	0·83	1·15	0·79	1·24	0·45
MnO ..	n.d.	0·14	0·20	..	0·31
Total ..	100·67	99·69	99·57	99·89	100·00
Sp. Gr.	2·725	2·74	2·79	..	..

Norms.

Quartz ..	2·46	0·90	..	3·90	..
Orthoclase ..	15·46	17·24	9·45	7·78	..
Albite ..	37·20	37·73	30·39	31·44	..
Anorthite ..	12·23	13·90	16·68	28·91	..
Nepheline ..	..	..	1·14	..	..
Corundum ..	..	..	..	0·61	..
Diopside ..	9·34	3·00	13·24	..	..
Hypersthene	9·33	14·16	..	16·47	..
Olivine ..	..	..	17·43	..	..
Magnetite ..	6·50	3·71	2·55	2·78	..
Ilmenite ..	3·19	3·50	4·41	3·50	..
Apatite ..	2·02	2·69	1·68	2·69	..
Water, etc. ..	3·07	2·93	1·92	1·86	..
Total ..	100·91	99·76	98·89	99·94	..
American Class	II. 5.2.4 Akerose	II. 5.2.4 Akerose	III. 5.3.4 Camptonose	II. 5.3.4 Andose	..

[4] Volc. Rocks, S.E., Qld., p. 177.

DESCRIPTION OF PLATE IV.

This shows six microphotographs of the anorthoclase basalt and of the various basalts with which it has been compared. The first four microphotographs have been taken with crossed nicols, and the last two in ordinary light. In all cases the magnification was 17 times.

No. 1.—*Anorthoclase Basalt* from Mapleton, Blackall Range. Microslide No. 266. In the centre of the field there is a phenocryst of anorthoclase showing simple twinning, inclusions of augite granules, &c., and a clear zone around the margin. The groundmass is composed of plagioclase, augite, olivine, and magnetite. Crossed nicols; magnified 17 times.

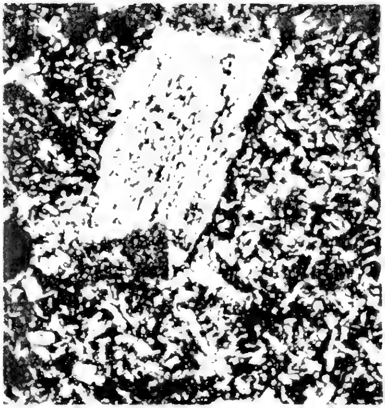
No. 2.—*Anorthoclase Basalt* from Mapleton. This is another portion of the same slide, as used for No. 1, and shows much the same features. Crossed nicols; magnified 17 times.

No. 3.—*Olivine Basalt*, Mapleton Falls, Mapleton, Blackall Range. Microslide 260. This rock immediately underlies the anorthoclase basalt. It contains phenocrysts of olivine set in a groundmass of plagioclase, augite, olivine, magnetite, and a greenish glass. Crossed nicols; magnified 17 times.

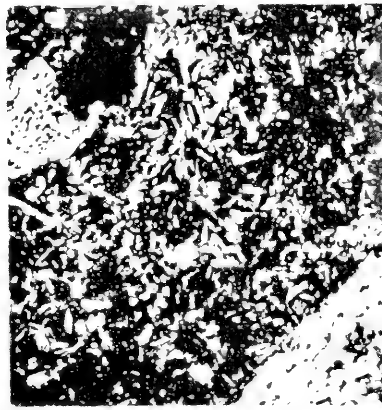
No. 4.—*Basalt* from road cutting near State School, Montville, Blackall Range. Microslide 262. This slide is representative of the basalts of Blackall Range, and is composed of plagioclase, augite showing ophitic structure, olivine, magnetite, ilmenite, and a greenish-brown glass. Crossed nicols; magnified 17 times.

No. 5.—*Basalt* from 3,000-ft. level. Eastern slope of Mt. Lindsay, MacPherson Range. Microslide 221. Occasional lath-shaped crystals of plagioclase occur in the hypohyaline groundmass, which is streaked parallel to direction of flow. Ordinary light; magnified 17 times.

No. 6.—*Oligoclase Basalt* from Spicer's Peak, Main Range. Microside 116. This slide shows the very fine-grained nature of the rock. The dark patch in the centre represents a crystal of olivine. Ordinary light; magnified 17 times.



1.



2.

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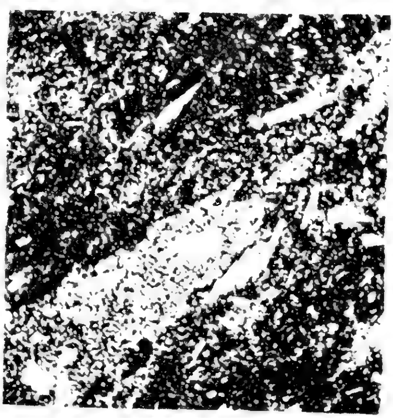
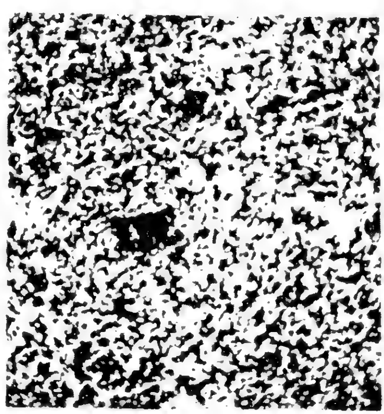


5.



6.

PETROGENIC SIGNIFICANCE.

In a previous publication[5] the author, in describing the Spicer's Peak oligoclase basalt, fully recognised its chemical difference from the ordinary sub-alkaline flows of Southern Queensland, and showed the close chemical relationship with that of the mugearites described by Harker[6] from Skye. Similar chemical characters were noted in the oligoclase basalt and the olivine basalt from Mount Lindsay, both of which terminated phases of effusion of lavas, the lower and upper basaltic series respectively, and the author wrote[7]: "Whether the occurrence of these rocks at the termination of two periods of activity during which basic rocks have been poured out is a mere coincidence or not, is a question." It is a matter of very considerable interest to find that this alkaline basalt from Mapleton, which has the same peculiar chemical characters as the basalts from Spicer's Peak and from Mount Lindsay, like them also represents the concluding effusion of a volcanic phase—the Upper Basaltic one.

One would expect the concluding effusions of each of these phases to be more differentiated than the earlier flows, owing to the law of increasing divergence, but the alkaline character of the last flow in each case has a particular interest and certainly does not support Daly's assimilation hypothesis as to the origin of alkaline rocks.

In conclusion, I extend to Miss Rose Scott, M.Sc., and Mr. G. J. Saunders, B.E., M.Sc., my thanks for carrying out, when advanced students at the University, the two analyses which have hitherto been unpublished, and which have been of the greatest help in the points considered in this paper.

[5] "Volcanic Rocks of South-Eastern Queensland," Pr. Roy. Soc. Qld., xxvii., 1916, p. 172, p. 176.

[6] Harker, "Tertiary Igneous Rocks of Skye," p. 263.

[7] Op. Cit., p. 192.

Note on the Walloon Jurassic Flora.

By J. H. Reid.

(*Read before the Royal Society of Queensland, 31st August,* 1922.)

Until the past two years very little geological work had been devoted to the Walloon formation in Southern Queensland, and although fossil plants are abundant therein, the lack of systematic collecting and of stratigraphical data has been a serious drawback to previous palæontological work. The Flora of the Ipswich and Walloon Series has been described by Dr. Walkom on all the local material available up to 1916.[1] Since then, as the result of field work by officers of the Geological Survey, extended collecting has been possible and the material available is now much more complete.

This work comprises a reconnaissance survey of the Roma District by Dr. H. I. Jensen[2]; also a detailed survey of the Rosewood Coalfield[3] and a reconnaissance survey of the West Moreton district by the writer (in Press). No detailed work has been done in the Darling Downs area, but the omission is probably not important, since the beds there are undoubtedly continuous with the Moreton beds under a narrow strip of basalt along the Toowoomba Range, and the northern portion of the Downs is probably on the same stratigraphical horizon as some of those examined in the Moreton district. It is tolerably certain that the Walloon formation extends unbroken between Beaudesert and Roma districts, covered in places by more recent deposits. Certain important palæontological conclusions present themselves as a result of this work, which were not so obvious previously, and which connote marked differences between the Ipswich Flora and that of the Walloon, other than those noted by Walkom.

The predominant species of the Ipswich formation are the various species of *Thinnfeldia*, and the following are

[1] "Mesozoic Floras of Queensland," Pt. I. Q.G.S.P. 252 (1915), 257 and 259 (1919).

[2] Summary of report published in *Queensland Government Mining Journal,* March, 1921.

[3] Geology of Walloon-Rosewood Coalfield, *ibid,* June-September, 1921.

characteristic amongst others:—*Tæniopteris Tenison-Woodsi, T. Dunstani*, the large-leaved *T. Carruthersi, T. lentriculiforme,* and *T. Wianamattæ;* also *Cladophlebis australis.*

In the Walloon of Moreton district, *Cladophlebis australis* and, to a less degree, *Tæniopteris spatulata* are the predominant species. This holds good through a vertical section of strata probably 5,000 feet thick in the area lying between Marburg and Wilson's Peak. Both are recorded from Darling Downs and from Roma.

An important feature, however, is that no undoubted species of *Thinnfeldia* nor any of the *Tæniopteridæ*, except *T. spatulata*, were found in the Walloons of the Moreton district, nor during the detailed survey of Rosewood, where fossilferous beds are abundant, and where an intensive search for fossil evidence may be claimed to have been made.

Dr. Jensen has informed me that *C. australis* is the most abundant form in the Walloon at Roma, and that no species of *Thinnfeldia,* nor of *Tæniopteris,* other than *T. spatulata* were found in those beds. *Thinnfeldia odontopteroides* is, however, found there in Ipswich Beds underlying barren sandstones below the Walloon, but not associated with the Walloon plants. Walkom likewise does not record *Thinnfeldia,* and of the *Tæniopteridæ* only *T. spatulata,* from the Walloon of South-east Queensland, Darling Downs, and Roma.[4]

The only record of *Thinnfeldia* in the Walloon of Moreton District is *T. odontopteroides* var. *falcata,* from Rosewood Scrub, 10 miles from Ipswich, identified by Tenison-Woods[5] and included in the synonymy of *T. lancifolia* by Walkom.[6] A provisional determination by Tenison-Woods[7] of a specimen as *Gleichenia lineata* from the same locality is regarded by Walkom as a doubtful synonym of *T. acuta,* but this can be disregarded owing to the degree of doubt as to its identity. I can only assert that during the detailed survey of the Rosewood coalfield,

[4] Geology of the Lower Mesozoic Rocks of Queensland. A. B. Walkom. Proc. Linn. Soc. of N.S.W. Vol. XLIII., Pt. 1, pp. 78 and 79.

[5] Fossil Flora of the Coal Deposits of Australia. J. E. Tenison-Woods. Proc. Linn. Soc. of N.S.W. Vol. VIII., 1883.

[6] Q.G.S.P. 257, pp. 21-24.

[7] Op Cit., p. 94

all the fossiliferous horizons detected throughout the district were collected from and no species of *Thinnfeldia* were found. Tenison-Woods, however, asserts that the species described by him is by far the most abundant form in that locality, but that position I find undoubtedly belongs to *Cladophlebis australis*, which is present in practically every specimen collected. *T. spatulata* and *Sphenopteris* sp. are also prominent.

From all this evidence emerges the following conclusions:—(1) That *Thinnfeldia*, the predominant genus of the Ipswich Beds, appears to be practically, if not absolutely, absent from the Walloon in the districts mentioned; (2) that the large-leaved *Tæniopteridæ*, as well as *T. Tenison-Woodsi* and *T. Dunstani*, similarly do not ascend into the Walloon, as far as we know, this genus being only represented (though in great abundance) so far by *T. spatulata;* and (3) the overwhelming predominance of *Cladophlebis australis* in the Walloon.

In view of the field work done, involving the examination of many hundreds of specimens from widely separated horizons, I think these conclusions can be stated with confidence; and it is to be noted that the evidence from the three areas of Moreton, Darling Downs, and Roma districts is wholly in agreement on these points, and indicates a strong palæontological break between the Ipswich Series and the Esk Series on the one hand, and the Walloon on the other. There are other differences, of course, to which Dr. Walkom has drawn attention, notably those relating to the Gingkoales, Conifers, and Cycads. While *Thinnfeldia* has not been found associated with *Tæniopteris spatulata* in the Walloon in these areas, it is, of course, known that they have been recorded together in the Clarence Series and are frequently associated in the Talbragar Beds of New South Wales.

It is also of interest that *Thinnfeldia* has not so far been recorded from the Lower Cretaceous of Maryborough or the Styx Coalfield, and that the one record of the genus from the Burrum Lower Cretaceous Series is to be regarded as a doubtful determination.[8] Its range in Queensland rocks would thus appear to be possibly much more restricted than was previously thought to be the case.

[8] A. B. Walkom. Floras of the Burrum and Styx River Series, Q.G.S.P. 263, p. 15.

Notes on Species of Sagitta collected during a voyage from England to Australia.

By B. B. Gray, F.L.S.

(Figures 1-4.)

(*Read before the Royal Society of Queensland, 31st August, 1922*).

The *Sagitta* which are identified in this paper were collected by Doctor Moreau during a voyage from England to Australia *viâ* the Cape of Good Hope in the year 1919.

Thirteen species were obtained, three of which are regarded as new.

The method of collecting was by means of a tow-net attached to a sea tap, which was left open for an indefinite length of time.

An especial interest attaches to the material collected between Plymouth and Morocco, as in this haul twelve larval *Amphioxus* were taken.

I take this opportunity of thanking Professor T. Harvey Johnston, University, Brisbane, for his kindness in handing the specimens to me for identification.

Sagitta enflata Grassi.

Synonymy.—*S. lyra* Langerhans 1880; *S. gardineri* Doncaster 1902; *S. brachycephala* Moltschanoff 1907.

Several specimens of this species were obtained off the coast of West Africa in latitude 15° N. during August, 1919. Already recorded from the Atlantic, Indian, and Pacific Oceans between 40° N. and 40° S.

Sagitta hexaptera D'Orbigny.

Synonymy.—*S. mediterranea* Forbes 1843; *S. bipunctata* Krohn 1844; *S. tricuspidata* Kent 1870; *S magna* Langerhans 1880; *S. longidentata* Grassi 1881; *S. darwini* Grassi 1883.

Individuals of this form were obtained during the passage from St. Paul's Rocks to 122° E. longitude in September, 1919. Already recorded from the Atlantic, Indian, Pacific, and Antarctic Oceans.

Sagitta macrocephala Fowler.

One specimen of the above species was captured off the coast of West Africa in 15° N. latitude, during August, 1919, which agreed in all particulars with the type description, and in addition possessed a small spine-like projection on each papilla of the vestibular ridge, very similar to those figured by Michael (1911, Pl. III., 16, 17) for *S. gigantea* and *S. lyra*.

A few very small individuals, collected off the same coast during a run of 100 miles near the equator, I have placed, though with some hesitation, under this species, as, although all the features except the head agreed with the descriptions, the latter was very much smaller in proportion to the body than is generally the case.

Already recorded from the Atlantic and Pacific Oceans.

Sagitta minima Grassi.

This species was obtained on three occasions during the month of August, 1919—viz., during the voyages from Plymouth to Morocco, and from Madeira to the Canary Islands; off the coast of West Africa in latitude 15° N. Already recorded from the Atlantic, Indian, and Pacific Oceans.

Sagitta neglecta Aida.

SYNONYMY.—*S. septata* Doncaster 1902.

Several individuals were captured in August, 1919, during the voyage from Plymouth to Morocco. Already recorded from the Pacific and Indo-Pacific.

Sagitta pulchra Doncaster.

This species was taken off the coast of West Africa in latitude 15° N. during August, 1919. Already recorded from the Pacific and Indian Oceans and the Tasman Sea.

Sagitta robusta Doncaster.

SYNONYMY.—*S. hispida* (non Conant) Aida 1897; *S. hispida* Doncaster 1902; *S. ferox* Doncaster 1902; *S. japonica* Galzow 1910.

Specimens were obtained on three occasions during August, 1919, between Madeira and the Canary Islands;

off the coast of West Africa, in latitude 15° N.; and between Plymouth and Morocco. Already recorded from the Indian, Atlantic, and Pacific Oceans.

Sagitta regularis Aida.

SYNONYMY.—*S. bedfordii* Doncaster 1902.

Captured during the voyage from Plymouth to Morocco in August, 1919. Already recorded from the Indian and Pacific Oceans.

Sagitta setosa Langerhans.

SYNONYMY.—*S. germanica* Leuchart 1847; *S. bipunctata* Busk 1856; *S. enflata* var. Hallez 1909.

Individuals of this species were taken during August, 1919, off the coast of West Africa, in latitude 15° N. Already recorded from the North Sea.

Sagitta serratodentata Krohn.

This species was obtained in August, 1919, off the coast of West Africa, in latitude 15° N. Already recorded from the Atlantic, Indian, Pacific, and Antarctic Oceans.

Sagitta sp.

A small unidentifiable Sagitta was obtained during the run from Adelaide to Bass Straits during August, 1919.

Sagitta atlantica sp. nov.

(Fig. 1.)

A transparent but fairly firm form, somewhat resembling *S. pulchra*, but immediately distinguishable from the latter by the possession of a rayless anterior fin which is shorter than the posterior fin, and by the tip of the seizing jaw, which in *S. pulchra* has a pronounced swelling.

Length 7 mm; width 4·3 per cent. of the total length; tail length 25 per cent. of the total length.

Tail to ventral ganglion 70 per cent. of the total length.

Anterior fins 19 per cent. of total length, without rays, and reaching ventral ganglion.

Posterior fins 25 per cent. of total length; with rays

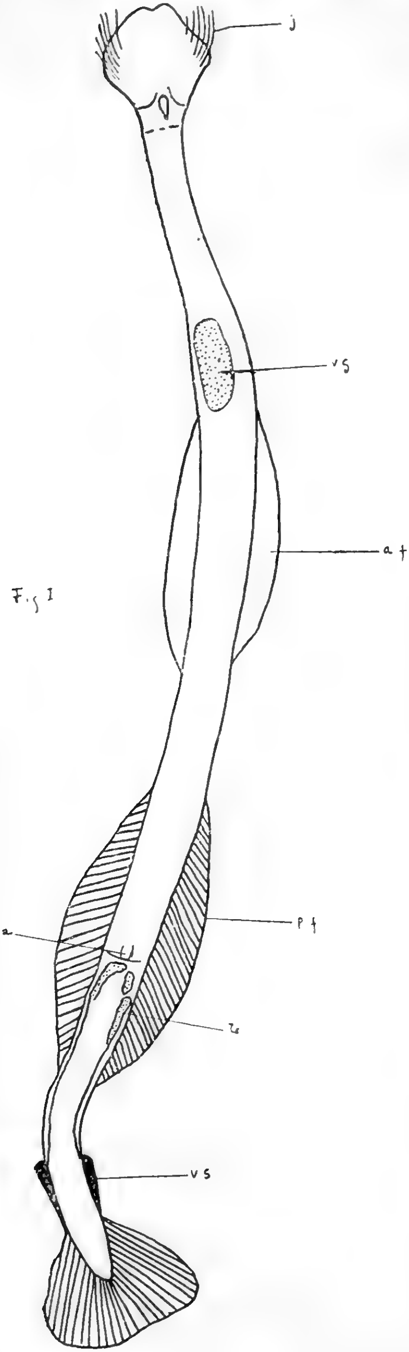


Fig I

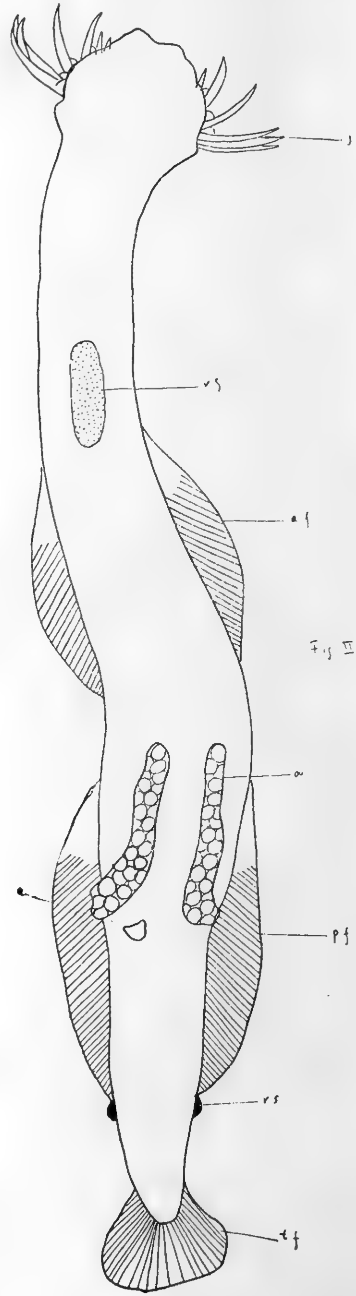


Fig II

except in a small anterior portion; 55 per cent. of the fins on the body; separated from the anterior fins by 10 per cent. of the total length of the body.

Anterior teeth 5; posterior teeth 8-9; seizing jaws 7.

Vesiculæ seminales fairly large, but not very prominent; they are touched by the tail fin, but are widely separated from the posterior fins.

Only one specimen was obtained; during the run from Madeira to the Canary Islands, on 27th August, 1919.

Sagitta equatoria sp. nov.

(Fig. 2.)

A firm opaque form with a very large head, which resembles *S. macrocephala* in this feature and in the width of the body, but is readily distinguishable by the anterior fins, which in *S. macrocephala* are only half the length of the posterior, and by the possession of twelve posterior teeth as compared to thirty-six in *S. macrocephala*.

Length 7·2 mm; width 12 per cent. of the total length; tail length 35 per cent. of the total length; tail to ventral ganglion 64·4 of the total length.

Anterior fins 19 per cent. of the total length of the body, with a rayless anterior portion, and reaching the ventral ganglion.

Posterior fins 22 per cent. of the total length of the body, with a rayless anterior portion, and reaching the vesiculæ seminales; more than 50 per cent. of the fins in front of the tail septum.

Anterior teeth 10; posterior teeth 12.

Seizing jaws 7, the tips are pointed, the shafts widely spread; vesiculæ seminales small, reached by posterior fins and separated from the tail fin; eggs few and large.

The solitary specimen from which this species is named was captured off the coast of West Africa in latitude 15° N. during August, 1919.

Sagitta moreauensis sp. nov.

(Figs. 3, 4.)

A firm semi-opaque form, which resembles *S. fridrici* and *S. bipunctata,* but differs from these in the following

Fig III

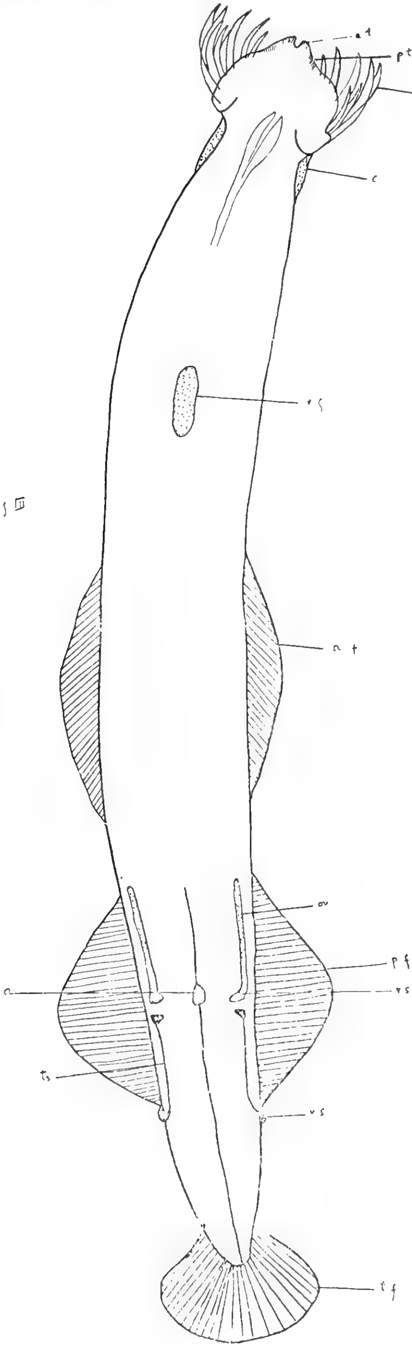


Fig IV

particulars:—The tail fin does not reach the vesiculæ seminales in the new species, but does so in *S. bipunctata;* the posterior fins are shorter than the anterior in the former, but are longer in the latter; in *S. bipunctata* there is a distinct constriction at the tail septum, but this is not the case in *S. moreauensis. S. fridrici* has less than 50 per cent. of the posterior fins on the body, and the vesiculæ seminales are reached by the tail fin. These features are not similar to *S. moreauensis.*

The solitary specimen which was captured reacted in a curious way to the reagents used in staining and mounting. When the specimen was examined and measured in formalin the width was 14 per cent. of the total length, and numerous sensory papillæ were present, but after mounting the width was reduced to 5 per cent. of the total length and the sensory papillæ had disappeared. All the other measurements remained unchanged.

Length 13·8 mm; width 14 per cent.; tail length 21 per cent. of the total length; tail to ventral ganglion 67 per cent. of the total length.

Anterior fins 21 per cent. of the total length; strong, oblique rays throughout; separated by a considerable distance from the ventral ganglion.

Posterior fins 18 per cent. of the total length, with strong rays throughout at right angles to the body; separated from the anterior fins by 5 per cent. of the total length; 50 per cent. in front of the tail septum; reach the vesiculæ seminales. Collarette small; anterior teeth 6, very long; posterior teeth 8-11; seizing jaws 10-12, widely spread; the tips of the jaws are embedded in shaft for one-half their length (Fig. 4). All the jaws are not visible in the figure, as some are masked by others when the head is in this particular position.

Vesiculæ seminales very small and inconspicuous; reached by the posterior fins, but not by the tail fin. Ovary with many small eggs.

The specimen was taken between Durban and St. Paul's Rocks during September, 1919.

All drawings have been made with a camera lucida from stained and mounted specimens, and corrected for distortion, shrinkage, and damage to the fins by drawings and measurements made in a liquid medium before staining.

Measurements are given without the fins.

TABLE OF STATIONS.

Station.	S. atlantica.	S. enflata.	S. equatoria.	S. hexaptera.	S. macrocephala.	S. minima.	S. moreauensis.	S. neglecta.	S. pulchra.	S. robusta.	S. regularis	S. setosa.	S. serratodentata.	S. species.	Approximate latitude.
1	..	..	..	..	..	×	..	×	..	×	×	..	..	..	50° N. to 35° N.
2	×	..	..	..	..	×	..	..	..	×	..	..	..	..	33° N. to 28° N.
3	..	×	×	..	×	×	..	..	×	×	..	×	×	..	15° N.
4	..	..	..	..	×	..	..	..	..	..	..	..	..	..	1° N. to 1° S.
5	..	..	..	..	..	..	×	..	..	..	..	..	..	..	30° S. to 38° S.
6	..	..	..	×	..	..	..	..	..	..	..	..	..	..	38° S.
7	..	..	..	..	..	..	..	..	..	..	..	..	..	×	35° S to 40° S.

1.—Plymouth to Morocco; 2.—Madeira to the Canary Islands; 3.—West Coast of Africa 15° N. latitude; 4.—West Coast of Africa 1° N. latitude to 1° S. latitude; 5.—Durban to St. Paul's Rocks; 6.—St. Paul's Rocks to 122° E. longitude; 7.—Adelaide to Bass Straits.

KEY TO THE SPECIES OF SAGITTA.

The following key to the species of *Sagitta* has as far as possible been based on those characters which are least likely to be rendered unreliable through damage during capture and subsequent treatment. In species where various authorities do not agree as to the presence or absence of any particular feature, the species is entered twice in the key, so that whichever case is correct the species may be identified.

	Collarette present	13
	Collarette absent	1
1.	Head very large	*macrocephala*
	Head normal	2
2.	Tip of seizing jaw hooked	3
	Tip of seizing jaw not hooked	4
3.	Shaft of seizing jaw serrated	*serratodentata*
	Shaft of seizing jaw not serrated	*minima*
4.	Neck constriction conspicuous	5
	Neck constriction not conspicuous	10

5.	Tail bilobed	*australis*
	Tail not bilobed	6
6.	Posterior teeth more than 15	7
	Posterior teeth fewer than 15	9
7.	Anterior fins with rays throughout	*elegans*
	Anterior fin with clear inner zone	8
8.	Width 8 per cent. to 12 per cent. of the total length	*enflata*
	Width 5 per cent. to 6 per cent. of the total length	*phillipini*
9.	Anterior fin reaches ganglion	*lyra*
	Anterior fin does not reach ganglion	*hexaptera*
10.	Posterior teeth more than 15	*setosa*
	Posterior teeth fewer than 15	11
11.	Tail more than 30 per cent. of the total length	*equatoria*
	Tail less than 30 per cent. of the total length	12
12.	Lateral fins confluent	*maxima*
	Lateral fins separated	*atlantica*
13.	Collarette long	14
	Collarette short	21
14.	Collarette very conspicuous	15
	Collarette not very conspicuous	18
15.	Collarette extends to vesiculæ seminales	*californica*
	Collarette does not extend to vesiculæ seminales	16
16.	Vesiculæ seminales reached by posterior fins ..	17
	Vesiculæ seminales not reached by posterior fins	*planctonis*
17.	Vesiculæ seminales reached by tail fin	*robusta*
	Vesiculæ seminales not reached by tail fin ..	*regularis*
18.	Tail more than 25 per cent. total length of body	*neglecta*
	Tail not more than 25 per cent. total length of body	19
19.	Anterior fin with rays throughout	20
	Anterior fin with clear inner zone	*enflata*
20.	Vesiculæ seminales reached by tail fin	*helenæ*
	Vesiculæ seminales not reached by tail fin ..	*elegans*
21.	Vesiculæ seminales reached by posterior fins ..	22
	Vesiculæ seminales not reached by posterior fins	27
22.	Vesiculæ seminales reached by tail fin	23
	Vesiculæ seminales not reached by tail fin ..	25
23.	Posterior teeth more than 14	24
	Posterior teeth fewer than 14	*pulchra*
24.	More than 50 per cent. of the posterior fin on body	*helenæ*
	Less than 50 per cent. of posterior fin on body	*fridrici*
25.	Tail more than 25 per cent. of total length ..	26
	Tail not more than 25 per cent. of total length	*elegans*
26.	Anterior fin longer than posterior	*neglecta*
	Anterior fin shorter than posterior	*tenuis*

27.	Width more than 7 per cent. of the total length	28
	Width less than 7 per cent. of the total length	29
28.	Opaque and firm	*moreauensis*
	Transparent and flaccid	*enflata*
29.	Seizing jaws 7 or more	*bipunctata*
	Seizing jaws never more than 7	*decipiens*

Text figures, 1-4.

Fig. 1.—*Sagitta atlantica* sp. nov. This drawing is incorrect with regard to the posterior fin, which actually has a small rayless anterior portion.

Fig. 2.—*Sagitta equatoria* sp. nov.

Fig. 3.—*Sagitta moreauensis* sp. nov.

Fig. 4.—*Sagitta moreauensis* tip of seizing jaw.

Reference to lettering: a.—Anus. a.f.—Anterior fin. a.t.—Anterior teeth. c.—Collarette. j.—Seizing jaw. ov.—Ovary. p.f.—Posterior fin. r.s.—Receptaculum seminis. s.—Shaft. t.—Tail septum. tp.—Tip of seizing jaw. ts.—Testis. v.g.—Ventral ganglion. v.s.—Vesicula seminalis.

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New and Known Australian Sarcophagid Flies.

By Professor T. Harvey Johnston, M.A., D.Sc., and O. W. Tiegs, M.Sc., formerly Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(Text-figures 1 and 2.)

As far as we are aware the whole of the literature relating to known Australian Sarcophagidæ is referred to in our two papers (1921, 1922). In the present contribution we have described a new genus and several new species, and have added additional locality records for many previously known forms.

The present paper is based mainly on specimens contained in the collections of the Queensland Museum, Brisbane, the Government Entomologist of New South Wales (Mr. W. W. Froggatt), and Dr. E. W. Ferguson, Health Department, Sydney. To these two entomologists and to Mr. H. A. Longman, Director of the Queensland Museum, we tender our thanks for the opportunity to examine the material referred to. The collection of Mr. Froggatt consisted of named and unnamed flies from various parts of Australia, and through his generosity in placing it at our disposal we have been enabled to clear up some synonymy. The abbreviations Q.M., W.W.F., and E.W.F. are used in connection with locality records to indicate the three collections respectively.

Mr. H. Hacker of the Queensland Museum has kindly assisted us by re-examining, at our request, type material of some of our previously described species.

1. Sarcophagids Recorded from Australian Grasshoppers.

The following species have been recorded as having been bred from Australian Locustidæ, viz.:—

(1) *Sarcophaga pachytyli* (Skuse) by Olliff (1891) and by Froggatt (1905) as infesting *Chortoicetes terminifera* (syn. *Pachytylus australis* Br.) from several localities in southern New South Wales;

(2) "A closely allied (if not identical) species" from the same species of locust from Richmond, New South Wales (Froggatt, 1905);

(3) *S. aurifrons* Macq. recorded by Froggatt (1905, 1907) as having been bred from the same species from Queanbeyan and Cooma, New South Wales;

(4) *S. œdipodæ* (Olliff) from *Chortoicetes terminifera.*

The first-named is more fully described in the present paper. An examination of Mr. Froggatt's collection shows that the specimens referred to under No. 2 belong to *S. peregrina;* while his material "*S. aurifrons*" from Queanbeyan belongs to *S. depressa.* In regard to No. 4, Olliff, in writing of the parasites of locusts, gave the name *Tachina œdipodæ* to a species "larger and more brightly coloured" than Skuse's *Masicera pachytyli.* This is the only description, though Froggatt in 1907 referred to the fly as a *Sarcophaga.* As we have pointed out (1922, p. 176), the name has no standing. The single specimen in Mr. Froggatt's collection was examined by us. It is not a member of the Sarcophagidæ, but has the general appearance of the Tachinid *Exorista,* though the arista is more like that of a Muscid.

2. Sarcophaga impatiens Walker.

Tambourine Mountain (S.E. Queensland)—Q.M.; North Pine (near Brisbane), Tamworth—W.W.F.

3. Sarcophaga gamma J. and T.

Brisbane, Bribie Island, Blackall Range.

4. Sarcophaga peregrina R.D.

Blackall Range, Brisbane, bred from the butterfly *Euploea corinna*—Q.M. Sydney; Kuranda (North Queensland)—E.W.F. Localities near Sydney; Gatton (Queensland)—W.W.F. Also from the locust *Chortoicetes terminifera,* from Richmond, New South Wales: the label on the pin states that the larva entered the soil on 5th March, 1904, the fly emerging on 20th March.

We may note that *S. fuscicauda* Böttcher (Entomol. Mitteilungen 1 (6), 1912, p. 168, fig 5) from Formosa is a synonym of *S. peregrina,* whose range is now known to include Houtman's *Abrolhos* (West Australia), Sydney, Brisbane, North Queensland, New Guinea, and Formosa. It will probably be found to occur in the East Indies and Philippines.

5. Sarcophaga eta J. and T.

A number of specimens bred from the beetle *Xylotrupes australicus* Thoms., Brisbane—Q.M. There is no indication as to whether they were parasitic or merely scavengers, but were probably the latter, as we have bred the species from carrion.

6. Sarcophaga aurifrons Macq.

Amongst Mr. Froggatt's material bearing the above name were representatives of the following species:—*S. depressa, S. froggatti, S. peregrina, S. misera,* and *S. impatiens.*

7. Sarcophaga froggatti Taylor.

Geraldton (Western Australia); Tamworth, Merriwa, Moree (New South Wales)—W.W.F. Also a specimen collected at Darwin, Northern Territory, by Mr. G. F. Hill and forwarded to Mr. Froggatt as *S. carnaria.*

Graham-Smith in his book on "Flies and Disease—non-bloodsucking Flies" (Edit. 2, 1914, p. 35) stated that *S. carnaria* was widespread and commonly occurred in England and Australia, and was not infrequently found in houses. We do not known on what authority the statement was made regarding its presence in Australia. We have not yet recognised it. It is quite possible that some fly similar in general appearance has been mistaken for it.

8. Sarcophaga zeta J. and T.

Bulli (New South Wales)—W.W.F.

9. Sarcophaga depressa R.D.

Geraldton and Mount Magnet (Western Australia); Sydney, Warrah, Coonamble, Yarrawin, Queanbeyan. Merriwa, Lower Hawkesbury River (all New South Wales localities); Gatton (Queensland)—W.W.F. Blackheath (New South Wales)—W.E.F. This is apparently the species usually referred to in Mr. Froggatt's papers as *S. aurifrons,* the two forms being closely related.

10. **Sarcophaga littoralis** J. and T.

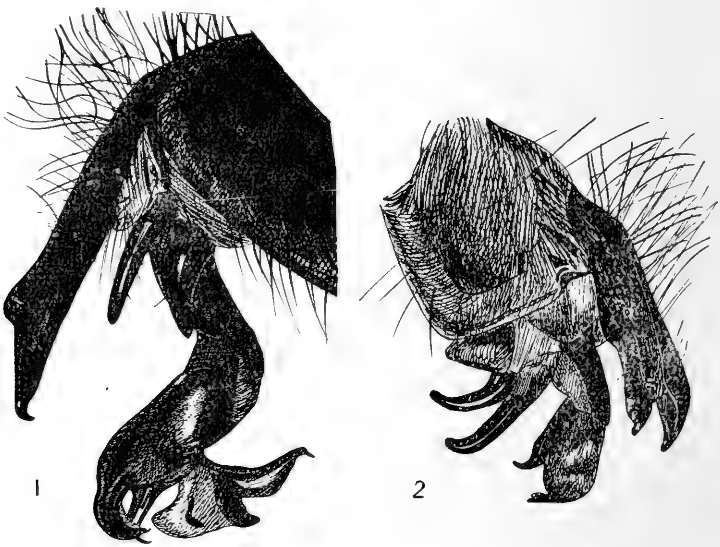
There is a specimen of this recently described species in the collection of the Queensland Museum. Locality, Tweed Heads.

11. **Sarcophaga brunneopalpis** n. sp.

(Text fig. 1.)

Male.

In general appearance a medium-sized fly, greyish and faintly golden in colour, with the usual black markings and measuring about 11 mm. in length. The species closely resembles *S. gamma*.



Head.—Frons not very prominent; about three-fifths the width of eye. Frontal stripe very broad, being half as wide again as parafrontals. Eyes a little over three-fifths the height of head. Parafrontals, occiput, genæ, and mesofacial plate faintly tinged with gold.

First antennal joint not very conspicuous; second fairly large and tipped with brown, third about twice the length of second. Ptilinal suture remains fairly distinct throughout life. Proboscis a deep chocolate brown, marked with black, clothed scantily with golden hairs terminally and with black hairs proximally. Palps, epistome and oral margin brown. Vibrissæ inserted rather close to oral margin and considerably weaker than usual. Eight epistomials, and about ten facials present. A row of ten frontals beside frontal stripe; verticals well developed; lateral verticals weak. A single row of black bristles behind eyes; occiput clothed with short pale golden hairs, becoming longer below and then shortening again on the anterior part of the genæ which also bears a small number of rather short black bristles.

Thorax about a wide as head, ashy coloured and faintly tinged with gold, with the usual three longitudinal black lines, of which the middle one alone extends definitely on to scutellum; sides of thorax distinctly tinged with gold. Anterior spiracle clad with pale brown hairs. Of the anterior acrostichals only the porterior pair is distinctly differentiated; of the posterior set, only the prescutellars are present. Three humerals; three intra-alars; dorsocentral row complete. Apical scutellars present.

Legs black; femora, especially the first, faintly tinged with gold. First femur and tibia not distinctly hairy. Second femur hairy on proximo-ventral two-thirds; distally a "comb" is developed. Third femur hairy, but not very heavily; tibia hairless.

Abdomen clothed dorsally with short black reclinate bristles, but ventrally it is much less hairy than usual. Hypopygium nearly black, hairy. Forceps very dark brown; the proximal halves approximated and very hairy; the terminal third bare, slightly curved, pointed and with a hump which is obvious when the organ is seen in lateral view. Claspers brown. The penis is not unlike that of *Sarcophaga gamma* in shape; first joint whitish, with black markings posteriorly; second light brown and black, provided with several hooks and processes (fig. 1), some white, others brown in colour.

Described from one male captured by Mr. H. Hacker in Brisbane, December, 1917.

Type in Queensland Museum.

12. Sarcophaga Fergusoni n. sp.

(Text fig. 2.)

In general appearance a large broad golden insect, measuring 14 mm. in length.

Male.

Head rather broad, measuring $3\frac{1}{2}$ mm. across the eyes. Height of eyes about two-thirds that of head. Front slightly over half the width of eye. Frontal stripe black, tinged with reddish brown, and measuring about twice the width of each parafrontal. Eyes red brown. Parafrontals dark golden, almost brown; occiput and genæ a beautiful brown colour. First antennal joint clearly visible, though not very large; second large, conical, nearly black; third about thrice the length of second, a brilliant brown colour, and tinged on outer border with black. Ptilinal suture lodged in a distinct depression completely surrounding the mesofacial plates and broadening out laterally, where it is coloured black. Mesofacial plate brown, with very short silvery pubescence and with borders tinged with black. About fourteen facial bristles present; vibrissæ not very large. Thirteen epistomials present. Palps a brilliant brown. Bristles on occiput golden, those clothing anterior part of genæ black. Two rows of black bristles behind eyes, of which the first is very regular, the second irregular. Verticals present; lateral verticals absent. A row of ten frontals beside frontal stripe.

Thorax about 4 mm. broad, golden, with the usual three black longitudinal stripes. Of these the middle stripe differs from that of all known Australian species in being exceedingly narrow; on either side of it occurs another longitudinal stripe rather more distinct than usual. The last two pairs of anterior acrostichals are slightly differentiated; of the posterior set, only the prescutellar pair is well developed; dorsocentral row complete; three humerals present. There is an indication of a third intra-alar.

Legs black. First femur tinged very faintly with grey, hairless; tibia slightly shorter than femur, also devoid of hair; tarsus slightly larger than tibia. Second leg hairless; femur devoid of a distinct comb. Third femur hairless; tibia hairy on its distal ventral half.

Abdomen relatively broader than usual and with usual markings; dorsal black line extends on to last segment, where it is trifurcated. Hypopygium nearly black and exceedingly small. Forceps rather straight, swollen distally and slightly hooked at termination; proximal half clothed rather scantily with a growth of long black hairs. Accessory plates not very prominent, dark brown; claspers black, simple. Penis heavily chitinised, quite black, and of a rather simple type. (Fig. 2.)

Described from a single male, collected by Dr. E. W. Ferguson, at Eccleston, Allyn River (Patterson River district), N.S.W. Type deposited in Australian Museum.

LOCUSTIVORA n. gen.

13. L. pachytyli Skuse.

Syns: Masicera pachytyli Skuse, in Olliff, Agric. Gazette, N.S.W., 1891, p. 251.

Sarcophaga pachytyli Coquillet, Insect Life, 5, 1892, p. 22.

Sarcophaga pachytyli Froggatt, Agric. Gaz., N.S.W., 16, 1905, p. 20.

Sarcophaga pachytyli Froggatt, Australian Insects, 1907, p. 315.

Sarcophaga pachtyli Johnston and Tiegs, Rec. Austr. Mus. 13 (5), 1922, p. 175.

In general appearance a rather small grey fly, 4½ to 5 mm. in length. Skuse stated that the length of the male was two lines (about 4 mm.) and the female 3 lines(about 6 mm.).

Male.

Head.—Front fairly prominent; eyes nearly four-fifths the height of head and about four and a-half times as wide as frons. Frontal stripe pale chocolate brown, nearly six times the width of parafrontals. The latter, together with the genæ and occiput, silvery, with dark reflections. Anterior portion of genæ tinged with brown. First antennal segment more conspicuous than usual; second large, brown with very faint silvery pubescence; third segment about one-third as long again as second, rather darker and with a more marked pubescence. Arista rather longer than the three antennal joints combined; proximal third plumose. Mesofacial plates brownish, showing through the silvery pubescence. Ptilinal suture fairly distinct. Vibrissæ strong. Four facials, the upper very small. Four epistomials. Bristles on anterior part of genæ black, exceedingly well developed; succeeding bristles brown; those on lower part of occiput silvery. A single row of black bristles behind eyes; below these bristles are others irregularly arranged. A single row of ten frontals beside frontal stripe. Verticals fairly well developed. Lateral verticals present. Proboscis dark brown, palps paler brown.

Thorax considerably narrower than head. Colour a rather silvery grey, with three longitudinal lines of a brown or black colour, the median one extending farthest back and alone reaching the scutellum. The two accessory median stripes more than usually distinct. Sides and ventral surface grey. Apical scutellars very well developed. Dorsocentral row of bristles complete; anterior ones rather larger than usual. Three intra-alars. Four humerals, of which the upper is very weak, the second even weaker, the lower two strong. The last three pairs of posterior acrostichals, so far as can be made out in the material available, are present. A row of five sternopleurals above the coxa of third leg. Anterior spiracle rather small, covered with brown hairs.

Legs brown and quite devoid of hairs. The bristle rows of first femur well developed. Besides the microchaetæ the second femur possesses only a few strong bristles, especially at its extremity; "comb" absent. On the third femur the microchaetæ are equally poorly developed. The third tibia is provided with a number of abnormally large spines.

Wings.—Cell 5R almost closed. Medio-cubital nervure almost reaching margin of wing. Alulæ and wings hyaline and quite transparent. Costal nervure spiny as usual; of the others only proximal part of vein R 4 + 5 hairy.

Since the abdomen is not present in the male material available, nothing can as yet be said about the male copulatory organs.

Female.

This differs from the male in the following respects:—Frontal stripe about as wide as parafrontals. A row of eight frontals beside frontal stripe, three others outside these and converging upon them above. Thorax as in male; apical scutellars absent; scutellum not so elongated as in male and possessing an almost semicircular shape. Abdomen clothed with short black reclinate bristles and a few large ones above; hairless ventrally. General colour silvery, the black markings very restricted and indistinct. Dorsal median black stripe practically absent.

Described from five imperfect specimens obtained from "plague locusts" (*Pachytylus australis* Br. = *Chortoicetes terminifera* Walker) from the following localities in New South Wales:—Whitton, Wagga, Cooma, Corowa. (Skuse, Olliff, and Froggatt material.)

The species was briefly described by Skuse in 1891 in an article by Olliff (Agric. Gaz., N.S.W., 1891), who added figures of the entire fly, the antenna and puparium. It was subsequently stated by Coquillet (1892) and by W. W. Froggatt (1907) to be a *Sarcophaga*. To the latter author we are much indebted for the opportunity to examine Skuse's type material (from Wagga and Corowa) which is in his possession.

The characters of the species, as given in the above description, show that it cannot be placed in the genus *Sarcophaga*. We have not been able to assign it to any of the other genera belonging to the family Sarcophagidæ. We have accordingly erected for its reception the new genus *Locustivora* whose characters may be defined as follows:—

A small, but fairly robust dark grey and black species. Thorax with the usual three longitudinal lines; the accessory median lines more than usually distinct. Front in male very narrow, eyes nearly four-fifths the height of head; but in the female the frons is considerably wider than in the male. Third antennal segment only a little longer than second. Arista plumose on proximal third only. Epistomials and facials few in number. A single row of weak parafrontal bristles. Legs devoid of hair, but moderately well supplied with bristles. Cell 5R of wing almost closed. Only vein R 4 + 5 hairy. Abdomen hairless. Type, *L. pachytyli* (Skuse).

Type specimens in collection of the Government Entomologist (W. W. Froggatt), Sydney.

W. B. Gurney (Agric. Gazette, N.S.W., 1908, p. 415) mentioned having found the fly in its larval stage parasitising locusts at Tocal, near West Maitland.

When referring to the species, Mr. Froggatt (1905, p. 20) stated that two specimens of a closely allied, if not identical, species were bred from *Chortoicetes terminifera*, taken at Richmond, N.S.W. These flies were examined by us and found to be *S. peregrina*.

LITERATURE.

1921.—JOHNSTON, T. H., and TIEGS, O. W. "New and little known Sarcophagid Flies from South-eastern Queensland," Proc. Roy. Soc. Q'land, 33 (4), pp. 46-90.

1922.—JOHNSTON, T. H., and TIEGS, O. W. "Sarcophagid Flies in the Australian Museum Collection." Rec. Austn. Mus. 13 (5), p. 175-188.

A Synonymic List of Some Described Australian Calliphorine Flies.

By Professor T. HARVEY JOHNSTON, M.A., D.Sc., and G. H. HARDY, Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

(*Read before the Royal Society of Queensland, 26th August*, 1922.)

NOT only have Australian blowflies been referred to under various synonyms in taxonomic papers, but also sundry combinations of generic and specific names have been utilised in designating them in works on economic entomology. The present paper is an attempt to elucidate the synonymy of those regarded as belonging to the genus *Calliphora* and its allies, and it will be noted that in addition to those previously determined, we have been able to subordinate no less than four generic and five specific names.

The excellent redescriptions of certain of Macquart's types by Surcouf (1914) have been of assistance in determining one name to be a synonym. The reasons for subordinating the others will be set forth in a paper, now in preparation, giving a detailed account of the structure and relationship of our Calliphorines.

The genera herein recognised are partly separable upon epistomal characters, since it will be noted that in some species, when seen laterally, the epistoma conspicuously protrudes at and below the vibrissa, whilst in others, viewed from the same aspect, this structure is only just visible. This character, though utilised at present by us, may not be satisfactory as gradations probably will be found when sufficient material shall have accumulated. The nature of the eyes, whether hairy or bare, is perhaps a more important character for primary separation and has been so utilised in the following key:—

1.	Eyes bare.	2.
	Eyes hairy.	3.

2. Epistoma conspicuously protruding .. .. .. *Anastellorhina.*
   Epistoma scarcely, if at all, protruding .. .. .. *Calliphora.*
3. Epistoma scarcely, if at all, protruding .. .. .. *Neocalliphora.*

Undetermined species of Australian Calliphorine flies are known to us and these belong to the genus *Calliphora,* whilst a species identified as *Neopollenia calliphoroides* Walker, not previously recorded from Australia, may possibly necessitate a further division of *Calliphora,* under which genus it would be placed according to our key.

Ochromyia nigricornis and *O. flavipennis* Macquart, belong to the *Tachinidæ*. Surcouf placed them respectively in his genera *Proekon* and *Amphibolosia.* A female specimen of each is in our collection.

Genus **CALLIPHORA** Desvoidy 1830.

Calliphora pubescens Macquart.

C. pubescens Macquart 1850.

Genus **ANASTELLORHINA** Bigot 1885.

Syns.—*Neopollenia* Brauer 1889.
Trichocalliphora Townsend 1915.
Paracalliphora Townsend 1916.
Proekon Surcouf 1914.

Anastellorhina stygia Fabricius.

Musca stygia Fabricius 1881; Wiedemann 1830.

Calliphora stygia Schiner 1868.

Neopollenia stygia Brauer 1889; Townsend 1915; Johnston and Bancroft 1920; Johnston and Tiegs 1921, 1922; Froggatt 1922.

Pollenia stygia Cleland 1911; Johnston and Tiegs 1921 (in error for *Neopollenia*); Miller 1921.

Calliphora villosa Desvoidy 1830; Macquart 1843, 1846; Froggatt 1905, 1914, 1915, 1916; Lea 1908.

Pollenia villosa Froggatt 1917.

Trichocalliphora villosa Townsend 1915.

Musca australis Boisduval 1835.

Ochromyia lateralis Macquart 1843.

Prockon lateralis Surcouf 1914.
Pollenia rufipes Macquart 1835; Brauer 1899.
Pollenia ruficornis Macquart 1847, 1850; Brauer 1899 (? *Neopollenia*).
Musca Læmica Walker 1849.
Anastellorhina bicolor Bigot 1885; Brauer 1898.

Anastellorhina tibialis Macquart.
Calliphora tibialis Macquart 1846.
Somomyia tibialis Brauer 1889.
Paracalliphora tibialis Townsend 1916.

Anastellorhina augur Fabricius.
Musca augur Fabricius 1775.
Anastellorhina augur Cleland 1911; Froggatt 1917; Johnston and Bancroft 1920.
Paracalliphora augur Johnston and Tiegs 1921, 1922.
Calliphora oceaniæ Desvoidy 1830; Macquart 1843; Schiner 1868; Froggatt 1905, 1914, 1915, 1916; Lea 1908.
Ochromyia lateralis Macquart 1843.
Prockon lateralis Surcouf 1914.
Calliphora rufiventris Macquart 1847.
Somomyia rufiventris Bigot 1899.
Musca dorsalis Walker 1849.

Genus **NEOCALLIPHORA** Brauer and Bergenstamm 1891.
Syn.—*Adichosia* Surcouf 1914.

Neocalliphora ochracea Schiner.
Calliphora ochracea Schiner 1868.
Neocalliphora ochracea Brauer and Bergenstamm 1891; Froggatt 1914, 1915, 1916.

Neocalliphora hyalipennis Macquart.
Ochromyia hyalipennis Macquart 1850.
Adichosia hyalipennis Surcouf 1914.

SPECIES OF UNCERTAIN GENERIC POSITION.

Musca (*Graptomyza*) *calliphoroides* Walker; a specimen from the Northern Territory, labelled "*Neopollenia calliphoroides* Walk., det. by E. E. Austen, 18.1.21, by comparison with type."

SPECIES WHOSE GENERIC AND SPECIFIC RELATIONSHIPS ARE OBSCURE.

Aureopunctata Macquart 1854 (*Calliphora*); Brauer 1899.

Clausa Macquart 1846 (*Calliphora*); Brauer 1899 (*Sonomyia*).

Dispar Macquart 1846 (*Calliphora*); Brauer 1899 (*Sonomyia-Onesia*).

Melanifera Bigot 1877 (*Somomyia*); Brauer 1899 (*Calliphora*).

Mortonensis Macquart 1854; (*Pollenia*); Brauer 1899.

Pusilla Macquart 1854 (*Calliphora*); Brauer 1899 (*Somomyia*).

Ruficornis Walker 1857 (*Musca*); Dr. E. W. Ferguson informs us that he received a letter from Dr. G. K. Marshall, Imperial Bureau of Entomology, dated 12th September, 1920, stating that this species belonged to *Calliphora*.

Rufipes Macquart 1843, 1847 (*Calliphora*); Brauer 1899 (*Neopollenia*); Townsend 1916 (*Paracalliphora*). Brauer gave *Calliphora rufipes* Macquart as a synonym of *Pollenia stygia* Fabricius. Townsend suggests the improbability of this. We consider Brauer confused Macquart's two names, *Pollenia rufipes* and *Calliphora rufipes* and therefore have substituted the former for the latter in the synonymy of *A. stygia*.

Tasmanensis Macquart 1850 (*Pollenia*).

Testaceifacies Macquart 1850 (*Calliphora*).

Viridiventris Macquart 1847 (*Pollenia*); Brauer 1899 (*? Neopollenia*).

An Unusual Rhyolite from the Blackall Range, South-Eastern Queensland.

By H. C. RICHARDS, D.Sc., Professor of Geology and Mineralogy, University of Queensland

(Plates V.-VI.)

(Read before The Royal Society of Queensland, 30th October, 1922.)

INTRODUCTION.

In a recent communication to this Society the author described an anorthoclase basalt—the first of its kind in Queensland—from Mapleton,[1] at the northern end of the Blackall Range in South-Eastern Queensland. The rock considered in this paper is from the same area, but is of a much rarer type and has many peculiarities, both structurally and chemically. It is a rhyolite with an extremely rich silica content and low alumina value ; it occurs near Montville, about the centre of the Blackall Range, and outcrops over an area of several square miles.

On account of its extreme values for silica and alumina and its interesting spherulitic and lithophysal characters it has a considerable intrinsic interest. Two recent scientific publications, however, give it a much wider interest.

Mr. R. Speight, M.A., in describing the rhyolites of Banks Peninsula,[2] in New Zealand, shows by analyses the character of the spherulites in comparison with the rhyolite, and accounts for the higher silica and magnesia and lower alumina of the former by the action of heated waters charged slightly with magnesian salts derived from basaltic lavas subsequently effused.

Spherulitic rhyolite, even more extreme chemically than the New Zealand one, is considered here, and the writer accounts for the pecularities by the action of heated waters and vapours accompanying the rhyolitic effusions themselves, so that the alteration and modification are not the result of ordinary atmospheric weathering, but rather due to agents of a magmatic origin coeval with the effusion of the rhyolites—the deuteric reactions of Sederholm.[3]

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[1] Proc. Roy. Soc. Qld. xxxiv., 1922.

[2] Rec. Cant. Mus. N.Z., Vol. ii., 1922, pp. 77-89.

[3] Bull. Geol. Soc. Amer., Vol. 33, 1922, p. 237.

In the "Geology of the Broken Hill District, N.S.W." by Mr. E. C. Andrews, B.A.,[4] the lack of consensus of opinion as to the origin of the so-called "quartzites" is mentioned.

It has been urged that the chemical nature of the "quartzites" is against their being regarded as originally igneous, but the writer hopes to show on the purely chemical evidence in comparison with the Montville rhyolite that it is not unreasonable to assume an original igneous nature for the quartzites.

FIELD OCCURRENCE OF THE RHYOLITE.

The Blackall Range, which has a general north and south trend and rises up to 1,500 feet or more above sea level, is situated 60 to 70 miles north of Brisbane. The range is composed of volcanic rocks of Cainozoic age resting unconformably on sandstones belonging to the Bundamba Series of (?) Upper Triassic age.

Skene's Creek, which is a tributary of the Obi Obi Creek, has its head waters on the western fall of the Blackall Range between Montville and Flaxton. After cutting its way through the basalt and andesite forming the upper portions of the Range, the creek flows in a general westerly direction into the Obi Obi Creek.

Following down the creek-bed a change from basalt to underlying rhyolite takes place in Portion 93v, Parish of Maleny, and after passing through Portion 73 into Reserve 546, there is, after two preliminary drops totalling about 80 feet, an almost sheer drop of 230 feet at the Bon Accord Falls. These falls are composed of the rhyolite under consideration.

Its field occurrence with its spherulites and fluxion structure is similar to many rhyolites of Middle Cainozoic age in Southern Queensland.

There is a wide distribution of the rhyolite as it is found in the Obi Obi Creek bed more than 2 miles south of the Bon Accord Falls, and it can be traced continuously between these points.

A thickness of at least 1,000 feet of rhyolite occurs, and may be determined by passing down into the Obi Obi Creek from Portion 132v through Portions 187 and 186.

[4] Mem. Geol. Survey N.S.W., Geology No. 8, 1922, p. 107.

Whether the rhyolite was effused from a central point or from a fissure cannot yet be stated, but there appears to have been a centre of effusion near Portion 143v in Skene's Creek, below the Falls, for we find breccia, agglomerate, and tuffaceous material of a rhyolitic nature.

GENERAL PETROGRAPHY.

There is much variation, both in colour and in structure, in the rhyolite. Fluxion and spherulitic structures are usually present, while the colour ranges from pink to grey.

Spherulites an inch in diameter occur in places, but they are nearly always altered either to kaolin or secondary silica. while often there is a kernel of silica inside a white fibrous aggregate. (See Plate V., figs. 2 and 3).

The occurrence of hollow spherulites is not uncommon, and at "The Narrows" on the Obi Obi Creek the rhyolite appears to be composed of a mass of lithophysæ showing concentric coats and hollow interiors and about 2·5 mm. in diameter. (See Plate V., fig. 1).

All the rhyolite occurrences appear to be slightly porphyritic, and both pink orthoclase showing simple twinning and about 2 mm. in length and occasional quartz crystals occur as phenocrysts.

The density of the rhyolite analysed was 2·545.

The rock, under the microscope, shows occasional lath-shaped phenocrysts of orthoclase and albite up to 1 mm. in length, set in a groundmass usually cryptocrystalline, but sometimes microcrystalline. The groundmass shows fluxion structure very frequently, while evidence of spherulitic structure is very common. Much alteration has gone on and both "secondary" quartz and kaolin occur very freely throughout the sections.

The original minerals were phenocrysts of pink orthoclase, albite, quartz, and very occasionally a ferro-magnesian mineral, possibly biotite, but invariably altered into chlorite, while in the glassy groundmass were developed rod-like aggregates of felspar.

The phenocrysts of felspar are moderately well preserved, and the extinction angle of the albite may be determined with but little trouble.

The groundmass in the rock at present appears to be made up of kaolin and secondary quartz, some of the latter occurring as allotriomorphic grains up to ·2 mm. in length in the cavities of the hollow spherulites.

The spherulites appear originally to have been both of the compact type (with radially arranged rods of felspar) and of the hollow type (lithophysæ). The former have been altered into kaolin and are frequently stained brown by limonite, while the latter have had their cavities filled by secondary quartz. The concentric rings of rod-like material forming the hollow spherulites have also in some cases been altered to quartz, for one frequently sees optical continuity throughout an allotriomorphic piece of quartz extending from the centre across the spherulitic ring and into the surrounding original groundmass.

The glassy groundmass has been thoroughly devitrified and now consists of a cryptocrystalline aggregate in which it is difficult to resolve the separate crystals.

The groundmass of the lavender-coloured rock on the south side of Skene's Creek in Portion 143v is very deeply coloured by reddish-brown flakes and rods of iron oxide. These appear thickly studded throughout the whole rock, and the rod-like crystallites which were formed in the glassy groundmass have been either replaced or deeply stained by iron oxide. (See Plate VI., fig. 2).

Professor G. A. J. Cole,[5] in his very interesting paper in 1885 on Hollow Spherulites, etc., describes an identical occurrence in the groundmass of the rhyolite from Beaver Lake, Yellowstone Park.

PETROGRAPHIC DESCRIPTIONS OF THE VARIOUS TYPES OF RHYOLITE.

Specimen 261A.[6]

This specimen, from which the material for the chemical analysis was obtained, was collected from the bed of Skene's Creek, about 100 yards above the highest falls in Reserve 546.

Megascopic Characters.—The rock is a very fine grained pink and grey rock, showing marked fluxion structure owing to the different colour bandings. Phenocrysts of pink orthoclase occur sparingly, but small rounded brown spherulites up to 0.6 mm. in diameter are abundant. (See Plate VI., fig. 1).

The specific gravity of the rhyolite is 2·545.

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[5] Q.J.G.S. 1885, p. 165.

[6] This and succeeding numbers apply to the collections in the University of Queensland.

Microscopic Characters.—There are occasional phenocrysts of orthoclase and albite up to 0·8 mm. long occurring in a cryptocrystalline groundmass. Spherulites up to 0·6 mm. long and brown in colour are seen and have a well-defined radial structure and for the most part are regular. The felspar rods have been altered into kaolin, which is much stained by limonite. Throughout the slide there are small blotches of kaolin and limonite.

The groundmass is composed of a devitrified glass, and it is impossible to resolve it into the individual grains which one presumes to be felspar and quartz.

Here and there throughout the field there occur irregular patches of a fine quartz mosaic which strongly suggest secondary silicification.

Specimen 473 from near the top of the Bon Accord Falls.

Megascopic Characters—This is a salmon-pink in colour and is very fine grained. Occasional phenocrysts of a pink and a white felspar are noted, while the even surface of the rock shows a structure which much resembles a fine graphic intergrowth. When viewed under the microscope one sees the structure is due to the arrangement in the altered groundmass of the kaolin, which is stained pink, and of the clearer secondary quartz granules which have developed in the cavities of the small hollow spherulites of which the rock was composed.

Microscopic Characters.—This rock section differs from the one described above (261A), owing to the possession of small oval and rounded patches of secondary quartz surrounded by thin circular shells which once represented walls of hollow spherulites or lithophysæ. (See Plate VI., fig. 3).

The rod-like aggregates of felspar and quartz which constituted the rock mass have undergone alteration, so that the felspar is either altered to kaolin or is replaced by secondary quartz.

The diameter of the spherulites appears to average about 0·4 mm., but there is much irregularity about the shape and the sizes as they range down to less than 0·1 mm. and up to 0·6 mm. in diameter.

The old walls of the spherulites show a rodded structure and are about 0·05 mm. thick. The walls are now mostly kaolin in nature, but frequently one sees secondary quartz granules optically continuous from the inside right across the walls to the o' mass material outside. The spherulites appear to have been originally hollow and the spaces have been filled with secondary quartz. As the original groundmass area has a pinkish staining through the kaolin and the secondary quartz is clear, the juxtaposition of these materials gives an appearance in the hand specimen somewhat resembling micrographic structure. The size of the granules of "secondary" quartz range up to 0·2 mm. long and is more than one might expect in such a fine-grained rock. The size is no doubt due in part to the size of the openings available in the hollow spherulites.

Specimen 264.

This comes from the south side of Skene's Creek, in Portion 143v, Parish of Maleny, and about ½ mile west of the Bon Accord Falls. It differs in appearance from most of the rhyolite and yields a chocolate-coloured soil.

Megascopic Characters.—The rock is a deep lavender colour and very fine grained. Small phenocrysts of a light-coloured felspar occur sparingly through the rock.

Microscopic Characters.—Phenocrysts of orthoclase, slightly cloudy, lath-shaped, and ranging up to 0·35 mm. in length and of quartz granules generally allotriomorphic, clear and ranging up to 0·3 mm. in diameter, occur set in a groundmass of a rather unusual type. (See Plate VI., fig. 2).

The groundmass is largely glassy, while through it are abundant acicular crystals of felspar, and both granules and rods of a reddish-brown iron oxide, which from its colour by reflected light appears to be hæmatite. As mentioned above, many of the rod-like crystallites which have been formed in the cooling glass appear to have been stained or replaced by this material in the same manner as those recorded by G. A. J. Cole for a rhyolite from Beaver Lake, Yellowstone Park.

The abundance of this iron oxide is rather surprising, and one finds difficulty in accounting for its concentration in this particular portion of the magma. In a basalt from Bundamba, near Ipswich, one finds the glassy base which occurs to a small amount thickly studded with black granules and rods of magnetite and perhaps ilmenite. This rhyolite, however, is almost entirely glassy, and the rods and granules, while similar in occurrence, are more like hæmatite. There appears to be a good deal of "secondary" quartz throughout the groundmass.

Specimen 475.

This comes from Portion 183, Parish of Maleny, and is about 1½ miles south of the Bon Accord Falls and on the other side of a basalt-capped ridge. There is little doubt that the rhyolite is continuous beneath the basalt capping, as it can be traced continuously around the end of the ridge from one point to the other.

Megascopic Characters.—It is a compact rhyolite much like 261A except that it does not show fluxion and spherulitic structures.

Microscopic Characters.—The rock has small phenocrysts of orthoclase and quartz set in a cryptocrystalline groundmass through which there is arranged much " secondary " quartz in the form of allotriomorphic granules.

Specimen 265.

This was obtained from the bed of the Obi Obi Creek, at " The Narrows," where the bed of the stream has cut a narrow canyon through the massive rhyolite flows. " The Narrows " occur at the south end of Portion 183, Parish of Maleny, and of Reserve 594, and are distant nearly 2 miles south of the Bon Accord Falls.

Megascopic Characters.—The rock is composed of spherulites, most of which are hollow and merit the term of " lithophysæ." Successive concentric rings around the hollows are visible in many of the spherulites. In size they average approximately 2·5 mm. The colour is pink to grey, and through the rock one sees occasional pink orthoclase phenocrysts.

Microscopic Characters.—The rock appears to be very much altered and to be composed of kaolin and secondary silica. The spherulites have been filled up with secondary silica, and the rods forming the concentric layers have been altered into kaolin. This rock is probably much of the same type as Specimen 473, except that the hollow spherulites were much smaller in the latter rock.

CHEMICAL CHARACTERS.

An examination of the complete chemical analysis reveals the somewhat remarkable character of the rock, and perhaps the very low alumina percentage (5·43) is even more surprising than the very high silica. The lime, magnesia, and total iron oxide percentages are very similar to those in the analyses of the average rhyolite and of the typical Southern Queensland rhyolites. It is then in the alkalies, alumina, and silica that one sees departures from the normal.

A perusal of the analyses in Professional Paper 99 of the U.S. Geol. Survey, by Dr. H. S. Washington, fails to furnish a lava flow which is so rich in silica as the rhyolite under consideration. The nearest approach to it is a metarhyolite described by J. S. Diller from Bully Hill Mine, California, but this latter rock is nearly 4 per cent. poorer in silica and 3.6 per cent. richer in alumina, and by its relative richness in magnesia and poverty in lime and alkalies indicates much more alteration than the Montville rhyolite.

A particularly interesting analysis for comparison is that of a spheroid from a pyromeride[7] from Wuenheim, in the Vosges. The analysis is given by Delesse in the Bull. Geol. Soc. France, and used by G. J. Cole in his valuable paper on the "Alteration of Coarsely Spherulitic Rocks" in the Q.J.G.S. in 1886, p. 189. The analysis is incomplete and the alkalies have been obtained by difference, so not much reliability may be placed on that value. The silica, however, is extremely high and the alumina very low, and Cole states, on p. 189, "The silica percentage has again, however, been probably raised by the removal of bases in solution."

In a recent publication on the "Rhyolites of Banks Peninsula," New Zealand,[8] Mr. R. Speight publishes an interesting analysis of a selected spherulite from the rhyolite on Quail Island, in Lyttleton Harbour. This analysis is given for purposes of comparison, and one notes that it is poorer in silica and much richer in alumina and magnesia than the rhyolite under consideration. The alkalies, too, are very much lower, especially the soda.

Mr. Speight, in comparing the analysis of the selected spherulite with that of the spherulitic rhyolite itself, states on page 82 "that of the spherulite shows traces of the effect of some agent, which has increased substantially the quantity of silica and magnesia, has increased slightly the amount of lime, and reduced materially the alkalies and the alumina. This has, in all probability, been effected by hot water, probably charged slightly with magnesian salts, the source of which it is tempting to assign to the basaltic lavas which subsequently to the rhyolitic eruptions inundated the locality."

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[7] A quartz-felsite or devitrified rhyolite characterised by conspicuous spherulitic or lithophysal structure, and thus having a nodular appearance. Nomenclature of Petrology by Arthur Holmes, p. 192.

[8] R. Speight. Rec. Cant. Mus. Vol. ii., 1922, pp. 77-89.

If one compares the Montville analysis with either the average rhyolite analysis given by R. A. Daly or with the several analyses of Southern Queensland rhyolites,[9] of which the one from Springbrook Plateau is typical, it will be seen that the variation lies in the silica, alumina, and alkalies.

There is undoubted evidence of "secondary" silica in the Montville rhyolite, and even if the silica percentage were increased 10 per cent. by its introduction one finds difficulty to account for the very low alumina. What removed the alumina? In what form was it removed?

The alkalies are much lower than in the ordinary rhyolites of Southern Queensland, particularly in respect to the potash. Delesse[10] insisted "strongly on the connexion between an excessive proportion of silica and the development of 'globular' or coarse spherulitic structure," and it is interesting to note that much of the Montville rhyolite is composed almost entirely of spherulites and many of them are decidedly coarse.

The norm of the rhyolite shows 27·30 per cent. of felspar, of which approximately two-thirds is albite and one-third orthoclase, while there is very little anorthite and no corundum. The norm of the spherulite from Quail Is., Lyttleton Harbour, has 17·04 per cent. only of felspar, of which anorthite is the most abundant, but in addition the norm shows 6·12 per cent. of corundum.

The paucity of the alkalies in the latter rock accounts for the difference in the felspar content and the need for forming corundum in the norm, so that one might assume that the Montville rhyolite has not been so much affected by loss of alkalies.

The Montville rhyolite is almost certainly Middle Cainozoic in age and is certainly post-Triassic, so that, although of the pyromeride type, it cannot be regarded as an ancient rhyolite. It shows devitrification to a certain extent, its felspars especially in many of the spherulites and lithophysæ have been kaolinised, and "secondary" silica occurs abundantly in much of the rhyolite.

Mr. Speight has regarded hot water charged slightly with magnesian salts as the agent causing the alteration in the spherulite from Quail Island, and assigns the origin of the water to the basaltic lavas poured out subsequently.

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[9] H. C. Richards, Proc. Roy. Soc. Qld. xxvii., 1916, p. 142.

[10] Mémoires de la Soc. Géol de France. 2 me série, tome iv., pp. 325., etc. Q.J.G.S. xlii., p. 188.

Chemical Analyses of Rhyolites, etc.

	Rhyolite Bon Accord Falls, Montville, Queensland.	Spheroid from Pyromeride, Vosges Mountains.	Spherulite from Rhyolite, Banks Pen., New Zealand.	Metarhyolite Bully Hill Mine, California, U.S.A.	"Quartzite," Municipal Quarry, Broken Hill, N.S.W.	"Quartzite" M.L. 38, Central Extended, Broken Hill, N.S.W.	Average Analysis of Liparites, and Rhyolites, after R. A. Daly.	Rhyolite, Springbrook Plateau, Southern Queensland.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
SiO_2	85·13	88·09	82·04	81·25	84·52	86·60	72·60	73·10
Al_2O_3	5·43	6·03	10·61	9·03	5·93	5·85	13·88	13·09
Fe_2O_3	0·48	0·58	1·26	0·63	1·00	2·96	1·43	1·19
FeO	2·72		0·36	0·40	2·88	0·07	0·82	1·43
MgO	0·37	1·65	2·04	2·48	0·68	0·15	0·38	0·43
CaO	1·04	0·28	1·44	tr.	1·50	2·00	1·32	0·87
Na_2O	2·05	2·53 (by diff.)	0·40	0·25	1·31	0·66	3·54	4·03
K_2O	1·54		1·09	1·82	1·28	0·82	4·03	4·92
H_2O + ...	0·50	0·84	0·80	2·81	0·68	0·20	1·52	0·54
H_2O −	0·32		0·46	1·09	0·10	0·22		Nil.
CO_2	..	..	..	..	0·04	..	0·06	..
TiO_2	0·19	..	0·05	0·08	0·24	0·20	0·30	0·39
P_2O_5	0·17	..	..	tr.	0·05	..	..	0·11
MnO	0·02	..	..	tr.	0·03	0·19	0·12	Nil.
SO_3	tr.	..	..	S. 0·35	..	..	..	..
BaO	..	..	..	0·05	..	..	..	..
Total	99·96	100·00	100·55	100·24	100·24	99·92	100·00	100·10
Specific Gravity	2·545	2·59	..	..	..	2·70	..	2·38

NORMS.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Quartz	63·78	..	69·36	68·82	66·24	74·82	33·36	28·56
Orthoclase	8·90	..	6·67	11·12	7·78	5·00	23·91	28·91
Albite	17·29	..	3·14	2·10	11·00	5·76	29·87	34.06
Anorthite	1·11	..	7·23	..	6·39	10·01	6·12	3·06
Corundum	..	..	6·12	6·53	..	0·20	1·43	..
Diopside	2·88	..	..	..	..	..	..	..
Hypersthene	3·77	..	5·10	6·33	5·92	0·40	1·00	2·02
Magnetite	0·70	..	0·93	0·93	1·39	0·23	2·09	1·86
Ilmenite	0·30	..	0·15	0·15	0·46	0·46	0·61	0·76
Haematite	..	..	0·64	..	..	2·88	..	..
Apatite	0·34	..	..	..	0·34	..	..	0·34
Calcite	..	..	..	..	0·10	..	0·10	..
Water, etc.	0·82	..	1·16	3·90	0·78	0·42	1·52	0·54
Total	99·89	..	100·50	99·88	100·40	100·18	100·01	100·11
C.I.P.W. Classification ..	I. 2.1.4	..	I. 2(2).3.2	I. 2.1.2	I. 2(2).3.3(4)	I. 2.4.3	I. (3)4.2.4	I. 4(3).1.3

I. Rhyolite, Bon Accord Falls, Montville, Blackall Range, Queensland. Analyst: G. R. Patten, Agric. Chem. Lab. Brisbane.

II. Spheroid from Pyromeride, Wuenheim, Vosges. Q.J.G.S. xlii., p. 189.

III. Spherulite from Rhyolite, Quail I., Lyttleton Harbour, New Zealand. R. Speight. Rec. Cant. Museum Vol. ii. 1922, p. 82.

IV. Metarhyolite, Bully Hill Mine, Shasta County, California. U.S.G.S. Prof. Paper 99, p. 51.

V. "Quartzite," Municipal Quarry, Broken Hill, N.S.W. Mem. Geol. Surv. N.S.W. No. 8, 1922, p. 315.

VI. "Quartzite," M.L. 38. Central Extended, Broken Hill, N.S.W. Mem. Geol. Surv. N.S.W. No. 8, 1922, p.371.

VII. Average Liparite and Rhyolite Analysis. R. A. Daly, Igneous Rocks, 1914, p. 19.

VIII. Rhyolite. Springbrook Plateau, Southern Queensland. Proc. Roy. Soc. Qld., xxvii., p. 143. Analyst: G. R. Patten, Agric. Chem. Laby., Brisbane.

At Montville there have been andesitic and basaltic outpourings subsequent to the effusion of the rhyolite, but while one is inclined to assign the cause of much of the alteration and silicification of the rhyolite to heated waters and vapours, there does not seem to be any need, especially in this case where the magnesia content is not increased, to invoke the succeeding basic flows as the source.

It is believed (*a*) that heated waters containing silica in solution and also carbonic acid gas and other constituents have been responsible for the alteration and "weathering" of the rhyolite, (*b*) that this has gone on in the last stages of the cooling down of the lavas, and (*c*) that the source of these agents is magmatic and not atmospheric.

Dr. Harker[11] has stated that there is every reason to believe that in the tertiary basalts of the British area many minerals, such as various zeolites with chloritic minerals, etc., have been formed from the partial decomposition of minerals in basalt as a result of water and gases of magmatic origin, while J. J. Sederholm[12] has given the term "deuteric" to those reactions of the very closing stages of crystallisation and dependent on the mineralisers or "juice."

Deuteric action of this type is therefore regarded as the cause of the peculiar chemical and mineralogical composition of the Montville rhyolite.

COMPARISON OF THE CHEMICAL CHARACTERS OF THE RHYOLITE WITH THOSE OF THE BROKEN HILL "QUARTZITES."

In view of the difference of opinion[13] as to the origin of the Broken Hill "quartzites," the chemical analysis of this rhyolite has much interest. These rocks have been studied at much length by Mr. E. C. Andrews, Dr. W. R. Browne, and Dr. F. L. Stillwell. The two latter, who are highly skilled petrologists, have made special petrological studies of these metamorphic rocks in the field and laboratory, and while Dr. Stillwell advocates a sedimentary origin, Dr. Browne prefers an igneous origin.

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[11] Nat. Hist. of Igneous Rocks, p. 308.

[12] J. F. Kemp, Bull. Geol. Soc. Amer., Vol. 33, 1922, p. 237.

[13] Geology of the Broken Hill District. Mem. Geol. Surv. N.S.W Geology No. 8, 1922, p. 107.

The chemical composition of the quartzites has been regarded by some as being against an igneous origin, especially on account of the high silica, low alumina, and low alkalies.

If one compares the two analyses of the quartzites with that of the rhyolite, the only respect in which they differ is in the lime and alkali content; but in one case—that of the quartzite from the Municipal Quarry—there is really very little difference at all.

A comparison of the norms of the rhyolite and this latter quartzite is very interesting.

Mineral.	Montville Rhyolite.		Broken Hill Quartzite.	
	per cent.		per cent.	
Quartz	63·78		66·24	
Orthoclase	8·90		7·78	
Albite	17·29	18·40	11·00	17·39
Anorthite	1·11		6·39	
Diopside	2·88	6·65	..	5·92
Hypersthene	3·77		5·92	
Magnetite	0·70		1·39	
Ilmenite	0·30		0·46	
Apatite	0·34		0·34	
Calcite	..		0·10	
Water, etc.	0·82		0·78	
Total	99·89		100·40	

The quartz, orthoclase, albite-anorthite, diopside-hypersthene, ilmenite, and apatite percentages are very similar. The rhyolite has almost all of its albite-anorthite material as the soda felspar, while in the quartzite the lime felspar is relatively more abundant.

The norm of the quartzite selected—from the Municipal Quarry—is much closer to the rhyolite than the other quartzite quoted in the analyses, but at least one may say that it is not unreasonable on the evidence of the analyses to postulate an orignial igneous origin for the Broken Hill quartzites.

In conclusion, I would like to express my best thanks and appreciation to Mr. J. C. Brünnich, F.C.S. (the Agricultural Chemist, Brisbane), for granting facilities for obtaining the chemical analysis of the rhyolite, and particularly to Mr. G. R. Patten for carrying out the same.

Description of Plate V.

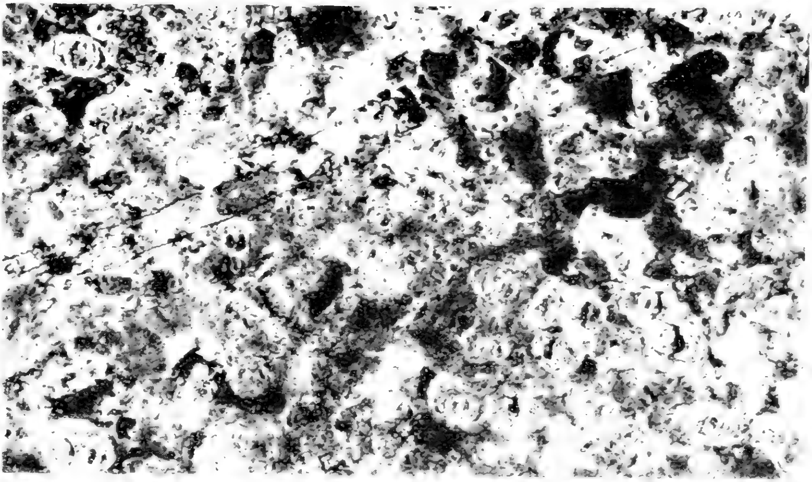
Plate V. shows four photographs of hand specimens of the Montville rhyolite. The first three are mangified $\times$ 2 and the fourth $\times \frac{19}{16}$.

Fig. 1.—*Rhyolite* from the Narrows, Obi Obi Creek, showing the lithophysæ with their hollow rounded form and concentric coats. Magnified $\times$ 2.

Fig. 2.—*Rhyolite* from Bon Accord Falls. It shows the spherulites light in colour in a cryptocrystalline groundmass. Phenocrysts of pink orthoclase occur through the rock sometimes as a nucleus to the spherulite. Magnified $\times$ 2.

Fig. 3.—*Rhyolite* from The Narrows, Obi Obi Creek, showing very well the spherulitic structure and containing much more "secondary" quartz than most of the rhyolites. Magnified $\times$ 2.

Fig. 4.—*Rhyolite* from Bon Accord Falls, showing the fluxion structure. Magnified $\times \frac{19}{16}$.



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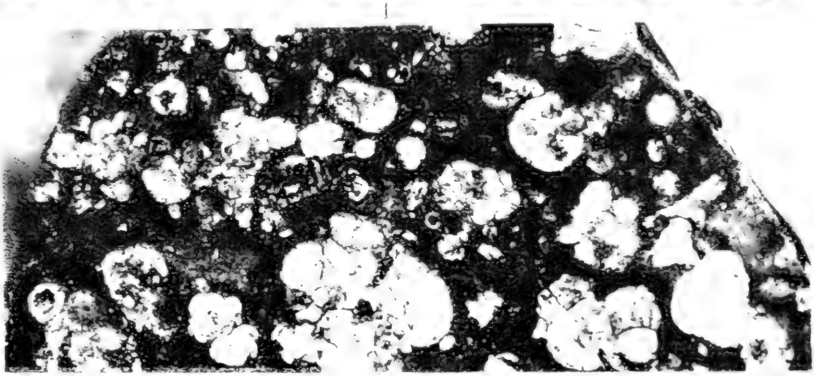

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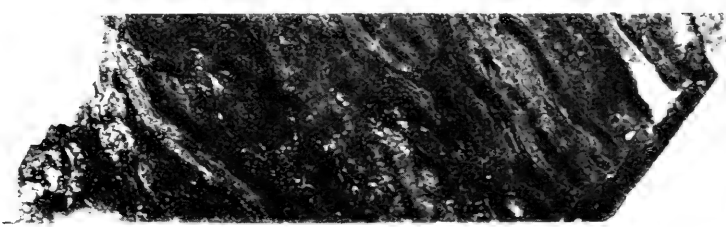


4

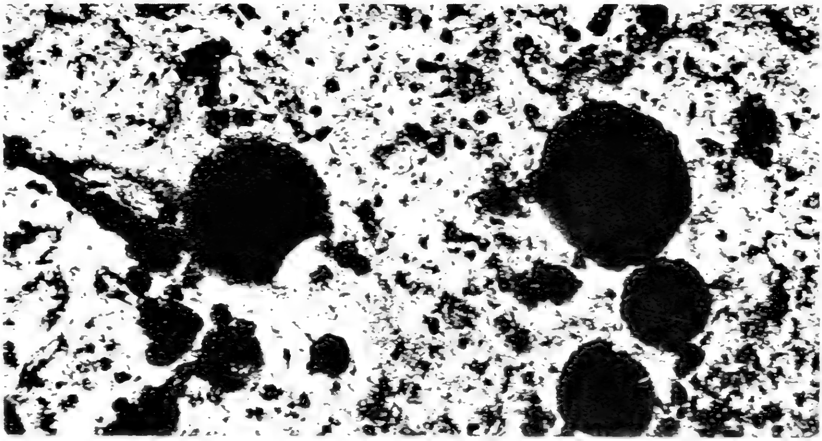
Description of Plate VI.

Plate VI. shows three microphotographs of the Montville rhyolite in ordinary light.

Fig. 1.—*Rhyolite* in microslide 261A, from Bon Accord Falls. It shows the spherulitic structure very well, also the very fine cryptocrystalline groundmass. The spherulites have a radial structure, and are composed of kaolin much stained with limonite. Ordinary light. Magnified × 50.

Fig. 2.—*Rhyolite* in microslide 264, from Skene's Creek, ¼-mile below the Bon Accord Falls. This shows the small rods and granules of hæmatite which occur so abundantly throughout the hypohyaline groundmass. The white patches represent felspar fragments and holes. Ordinary light. Magnified × 35.

Fig. 3.—*Rhyolite* in microslide 473 from Bon Accord Falls. It shows the oval to rounded character of the hollow spherulites, the thin walls of which show a radial arrangement of rod-like forms and the interior a nucleus of "secondary" quartz. Ordinary light. Magnified × 50.



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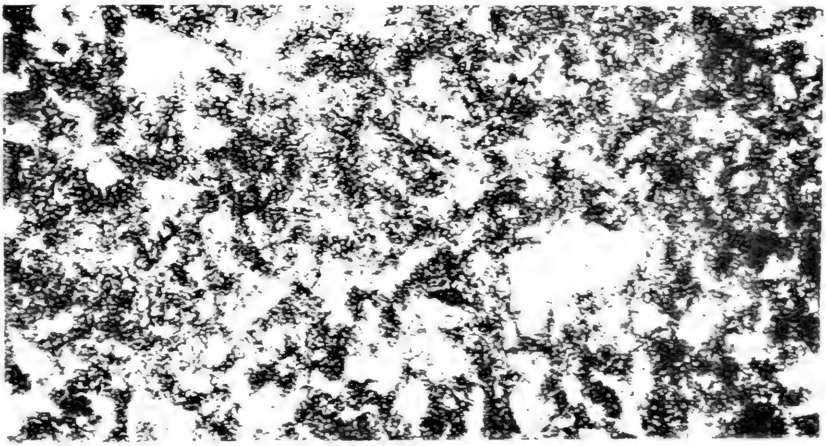

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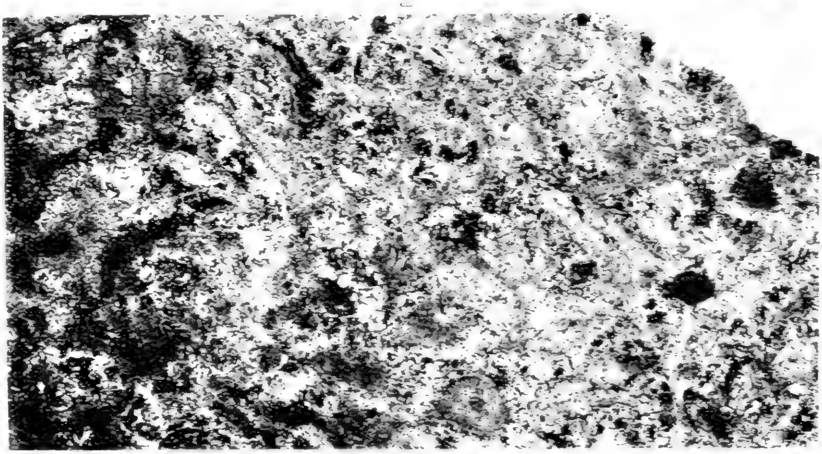

3

Some Characteristics of Queensland Rain Forests and Rain-Forest Trees.

By W. D. FRANCIS, Assistant Government Botanist.

VERY few field observations of our rain-forest or so-called "scrub" trees appear to have been made and recorded by botanists, although the open or hardwood forest trees, especially the Eucalypts, have received a considerable amount of attention. Perhaps the difficulties of determining the rain-forest species in the field may account for part of the botanists' neglect of them, as the recognition of the various species in their wild state presents several obstacles, such as the inaccessibility of the leaves, flowers, and fruit, the apparent similarity of so many of the trees, and the very large number of species crowded into a limited area.

In the latter part of this paper the writer has endeavoured to facilitate the recognition of some of the rain-forest trees by placing on record some of their peculiarities. It is not claimed that these peculiarities are exhibited in all cases, but experience has shown that a large number of them is serviceable in the field in the specific, generic, or ordinal determinations in which they are stated to be applicable. Most of the observations were made by the writer during a residence of several years in the rain forest at Kin Kin, North Coast line, or whilst on short official visits to rain forests in various parts of the State.

It is well known that the Eastern Australian rain-forest flora, in contrast with the true or old Australian type of vegetation as exemplified by the Eucalyptus forests, is allied to the Papuan and Malayan floras, and is often referred to as chiefly constituting the Austro-Malayan type. Although allied to Papuan and Malayan ones, the great majority of the Australian rain-forest species is endemic.

THE RELATION OF RAIN FORESTS TO RAINFALL.

The dependence of our luxuriant rain forests upon heavy rainfall is unquestionable. The heavy or luxuriant rain-forest areas of the State appear to have an average annual rainfall approximating or exceeding 60 inches. The areas in which this condition of rainfall prevails generally, if not always, contain relatively large areas of rain forest of the luxuriant type. A meteorological map showing the distribution of rainfall in Queensland indicates roughly the following areas with rainfalls approximating or exceeding 60 inches annually:—

(1) The extreme south-eastern portion of the State, including the MacPherson Range and Tambourine Mountain;

(2) The North Coast line district, between Landsborough and Cooran;

(3) The small area round Yeppoon;

(4) The area between Mackay and Proserpine;

(5) The fairly large area to the north, south, and west of Cairns; and

(6) The northern part of Cape York Peninsula.

All of these areas, with the possible exception of Cape York Peninsula, whose flora is not very well known, contain tracts of heavy rain forest. Following are the average annual rainfall registrations, in inches, of meteorological stations situated in or near the rain forests of the areas enumerated:—

(1) Tweed Heads 70, Tambourine Mountain 64;

(2) Landsborough 67, Montville 70, Nambour 60, Cooran 56, Kin Kin 57;

(3) Yeppoon 65;

(4) Eungella 72 for 1913, Mackay 69; and

(5) Cairns 90, Atherton 53, Harvey's Creek 165.

It is evident that the luxuriant rain forests are indicative of a heavy rainfall.

On the other hand, certain types of vegetation—for example, brigalow (*Acacia harpophylla*) "scrub"—indicate a relatively low rainfall. Extensive areas of brigalow forest occur between Dalby and Roma on the Western, between Warwick and Goondiwindi on the South-Western line (C. T. White), and between Westwood and Emerald on the Central line. These three areas have an average annual rainfall of from 20 to 30 inches. The prevalence of brigalow in coastal areas, as at Marmor, south of Rockhampton, with an average rainfall of 34 inches at Raglan (the nearest meteorological station), and at Rosewood, with 32 inches, appears to signify coastal localities with low rainfalls.

Rain forests of a type less luxuriant than those of the fertile areas of MacPherson Range and the North Coast line occur in many parts of the State, especially in the coastal area. Following are some of the locations of these less heavy rain forests, with the annual rainfall of the locality in parentheses:—Myer's Ferry, near Southport (55), Rosewood (32), Goodna (37), Imbil (45), Theebine (40), Marmor (Raglan, nearest station, 34). This type, which is not so aptly described by the term "rain forest," occurs in areas of great or less extent from the Tweed River in the south to Rockhampton, and probably, from what the writer has heard, as far as Cooktown in the north.

THE RELATION OF RAIN FORESTS TO SOIL.

Both the luxuriant and the less heavy types of rain forest abound on soils derived from various kinds of rock. Following is an enumeration of some of the heavy rain-forest areas, showing the kinds of rock from which the soils are derived:—The MacPherson Range areas, such as Roberts' Plateau, Tambourine Mountain (basalts and andesites)[1]; Blackall Range (basalts) (H. I. Jensen); Kin Kin (phyllites and slates)[2]; the area between Beenham Range and Kin Kin (granodiorite)[3]; and the Eungella Range, westward of Netherdale, Mackay district (granodiorite).[4]

SOME EFFECTS OF SOIL, RAINFALL, AND CLIMATE ON RAIN FORESTS.

The character of the luxuriant rain forests of areas such as Tambourine Mountain, Kin Kin, and Eungella Range shows that in those localities the conditions of soil and rainfall approach the optimum. The heavy rain forests of the MacPherson Range, such as those of Roberts' Plateau,

[1] H. C. Richards, Proc. Roy. Soc. Q., Vol. xxvii, plate x (1916).

[2] L. C. Ball, Q'land Govt. Mining Journ., p. 58, Vol. xix., Feb. 1918.

[3] L. C. Ball, loc. cit.

[4] L. C. Ball, Q'land Geo. Survey Pubn. No. 224, p. 27 (1910).

are situated at an altitude of 3,000-4,000 feet, and the climate is therefore temperate. They only differ in general character from those at lower levels further north, where the climate is subtropical, in containing less undergrowth. The less luxuriant types of rain forest often grow in poor soils, especially where the rainfall is high. This fact is exemplified at places such as Myer's Ferry, south of Southport, where a rain forest of the lighter kind flourishes in the sandy soil adjacent to the ocean beach. The soil in this and similar localities is composed of grains of silica in very high proportions, and plant food must be present in low percentages. In cases of this kind it appears obvious that a heavy rainfall (55 inches in this instance) is a very decisive factor in determining the character of the forest. On the other hand, in localities where the soil is fertile a rain forest of the lighter type is generally the result of a light rainfall. These conditions are seen in the light rain forests in the neighbourhood of Theebine (Kilkivan Junction), where the average annual rainfall is 40 inches and where the fertility of the soil is exhibited by the good crops grown in the felled areas.

SIZE OF RAIN-FOREST TREES.

Queensland rain-forest trees do not often exceed 160 feet in height and 6 feet in barrel diameter when measured above the basal flanges or plank buttresses. The fig trees (*Ficus* spp.), Queensland kauri pines (*Agathis* spp.), scrub box (*Tristania conferta*), and some species of Eucalypts such as the messmate (*Eucalyptus Cloeziana*) and the flooded gum (*E. saligna*), when growing in the luxuriant rain forests sometimes exceed 6 feet in barrel diameter. The Eucalypts which sometimes grow in the rain forests or on their margins often exceed the true rain-forest trees in height, but they do not grow beyond 200 ft. in height, so far as the writer is aware. The common form of rain-forest tree has a long barrel bearing a shorter canopy of branches and foliage. In some cases the barrels attain 80 or 90 ft. in height before they branch. In the light rain forests the size of the trees is sometimes reduced so that the general height is brought down to about 40 or 50 feet, and the barrel diameter of the larger trees to 12 or 18 inches.

BUTTRESSED BARRELS.

Many rain-forest trees are deeply flanged or buttressed (plank-buttressed) at the base of the barrel, a peculiarity which appears to be exhibited by certain species of trees in dense rain forests in tropical and subtropical parts of the world. J. H. Maiden[5] has recorded the buttressed character of several common Australian rain-forest trees. A. F. W. Schimper[6] remarks that the plank-buttress is a peculiarity of trees in a tropical climate with abundant rainfall, that the amount of rainfall necessary for its appearance is not yet ascertained, and that the physiological causes of the phenomenon and its significance to the life of the tree are still obscure. As plank-buttresses are common in all of the luxuriant rain forests mentioned previously in this paper, even in those at an altitude of 3,500 feet in latitude 28·2 degrees south, on the MacPherson Range, it can be definitely stated that in Queensland the phenomenon is not confined to tropical forests, but occurs in relatively temperate climates, and that it appears when the annual rainfall approximates or exceeds 60 inches.

A large number of species of Queensland rain-forest trees have plank-buttresses. Following are the most conspicuous trees which exhibit this peculiarity:—Fig trees (*Ficus* spp.), the carribin (*Sloanea Woollsii*), blueberry ash (*Elæocarpus obovatus*), quandong (*Elæocarpus grandis*), mountain beech (*Elæocarpus Kirtonii*), *Dysoxylon* spp., booyong (*Tarrietia argyrodendron*) and its varieties, black jack (*Tarrietia actinophylla*), water gum (*Eugenia Francisii*), *Eugenia Luehmanni*, *Eugenia* spp., red cedar (*Cedrela toona*, var. *australis*), marara (*Weinmannia lachnocarpa*), pink marara (*Geissois Benthami*), and the giant ironwood (*Syncarpia subargentea*). The buttresses of some species often assume characteristic shapes. For example, the carribin (*Sloanea Woollsii*), which is one of the most conspicuously buttressed trees, frequently has flanges whose edges curve outwards.

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[5] J. H. Maiden, "Australian Vegetation," Federal Handbook on Australia, issued in connection with visit of British Assn., 1914, p. 172.

[6] A. F. W. Schimper, "Plant Geography," trans. W. R. Fisher, revised and edited, Groom and Balfour, p. 305 (1903).

CHARACTERISTICS OF SOME RAIN-FOREST TREES.

Trees with Channeled or Fluted Barrels.—Some species are characterised by channeled or fluted barrels which are angular or sub-angular in cross-section. Unlike the buttressed trees, the channeled or fluted character is not always confined to the basal portion of the barrel, but often extends upwards towards the lowermost limbs. Examples are the churnwood or soap box (*Villaresia Moorei*), lignum-vitæ (*Vitex lignum-vitæ*), black apple or black plum (*Sideroxylon australe*), koda (*Ehretia acuminata*), she pine or brown pine (*Podocarpus elata*), giant stinging tree (*Laportea gigas*), scrub turpentine (*Rhodamnia trinervia*), and white myrtle (*Rhodamnia argentea*). Occasionally the churnwood, lignum-vitæ, and koda resemble each other in general appearance. The churnwood is one of the largest trees of the rain forests, and attains a barrel diameter of nearly 5 feet. It has a pale or whitish cork-like fissured bark. Its timber is pale or nearly white, and is remarkable for its broad medullary rays, which in tangential section measure 2-4 mm. or more in height. The lignum-vitæ has a bright yellow bark when cut. The rays of the timber are fine and inconspicuous, measuring from ·2-·7 mm. in height in tangential section. The koda (which is an Indian name for the species) is generally not so tall as the churnwood and lignum-vitæ, and it is frequently almost leafless in the spring. The rays of its timber appear to the unaided eye as minute specks which measure ·5-1·5 mm. in tangential section.

Trees with Conspicuously Fissured Barks.—The following rain-forest trees have prominently fissured barks comparable to that of ironbark:—Scrub ironbark (*Bridelia exaltata*), white cedar (*Melia Azedarach*), and red ash (*Alphitonia excelsa*).

Trees with Scaly Barks.—The scaly-barked trees are numerous. Some of the common species are bolly gum (*Litsea reticulata*), crow's ash (*Flindersia australis*), yellow-wood (*Flindersia Oxleyana*), crow's apple (Owenia *venosa*), red cedar (*Cedrela toona,* var. *australis*), white beech (*Gmelina Leichhardtii*), rosewood (*Dysoxylon Fraseranum*), scentless rosewood (*Synoum glandulosum*), deep yellow-wood (*Rhodosphæra rhodanthema*), and southern penda (*Xanthostemon oppositifolius*).

Trees with Very Smooth, Thin Barks.—The ironwood (*Myrtus Hillii*) and the giant ironwood (*Syncarpia subargentea*) have very smooth, thin barks. The bark of an ironwood 10 inches in barrel diameter measured $\frac{1}{16}$-inch thick; and that of a giant ironwood 3 feet in diameter $\frac{1}{8}$-inch thick. In both trees the surface of the bark is often bright-green or bright-brown. The ironwood rarely exceeds 10 inches in barrel diameter. The marara (*Weinmannia lachnocarpa*) has a thin but not very smooth bark, which measures $\frac{3}{16}$-inch on a tree with a barrel diameter of 2 feet 3 inches, and which is generally deep-red when cut.

Trees with Yellow Inner Barks.—The following trees have yellow inner barks:—Black bean or Moreton Bay chestnut (*Castanospermum australe*), lignum-vitæ (*Vitex lignum-vitæ*), blueberry ash (*Elæocarpus obovatus*), mountain beech (*Elæocarpus Kirtonii*), quandong or blue fig (*Elæocarpus grandis*), *Elæocarpus foveolatus*, *Elæocarpus ruminatus*, and *Elæocarpus sericopetalus*. The species of *Elæocarpus* generally have a yellow surface on the sapwood, which is seen when the bark is removed. This peculiarity is often a well-marked one, and proved serviceable to the writer recently in locating species of *Elæocarpus* in the Eungella Range. The inner surface of the bark in these trees is generally similarly tinted. It was noticed in the case of the blueberry ash that after some hours' exposure the yellow colouration turned to a bluish tint.

Trees with Ochre-Coloured Inner Barks.—At least two species of trees of the natural order *Celastrineæ*—namely, the ivorywood (*Siphonodon australe*) and the orange bark (*Celastrus dispermus*)—have very distinctive inner barks. When the outermost layer of bark is removed an inner layer of an ochre-yellow or brown colour is exposed in the ivorywood and an orange-coloured layer in the orange bark. This peculiarity of these two trees was pointed out to me by bushmen and others. Somewhat similarly coloured inner barks may be found in other species of this natural order.

Trees with a Wrinkled Surface on the Sapwood.—A large number of trees of the natural order *Sapindaceæ* and a few of the natural order *Laurineæ* have a peculiar wrinkled surface on the sapwood which is seen when the bark is removed. The wrinkles are disposed longitudinally and suggest the appearance of corduroy cloth, or in coarser examples, such as that provided by a species of *Cryptocarya*, they simulate the corrugations of a washing-board. This wrinkled surface has so far been observed in the following species of *Sapindaceæ*:—Native tamarind (*Diploglottis Cunninghamii*), *Cupania xylocarpa*, *Ratonia pyriformis*, *R. tenax*, corduroy (*R. stipitata*, wrinkles prominent), small tamarind (*Nephelium Lautererianum*, wrinkles prominent), *Nephelium semiglaucum*, *Heterodendron oleæfolium*, and *H. diversifolium*. The Lauraceous trees which exhibit this peculiarity are few in number. One of them is an undetermined species of *Cryptocarya* (referred to above) from Eungella Range, which is the only locality in which the wrinkled surface has so far been observed in *Laurineæ*.

Occurrence of Black Wood (Ebony) in Queensland Ebenaceæ.—The species of the natural order *Ebenaceæ*, of which there is a considerable number in our rain forests, very frequently contain patches, streaks, or specks of black wood similar in appearance to the ebony of commerce (species of *Diospyros* and *Maba*). These black patches, streaks, or specks have been observed in the following species of the order in Queensland:—*Maba humilis*, *M. geminata*, *M. fasciculosa*, *M. reticulata*, black myrtle (*M. sericocarpa*), *Diospyros pentamera*, and *D. hebecarpa*. In *Maba humilis*, which is known as native ebony, the black wood is developed in fairly large quantities. Solereder[7] states that the black colour of ebony is due to black or brown contents present in the wood vessels and in the lumina of the wood prosenchyma; that Belohoubek has shown that part of the black contents is soluble in caustic potash, and is due to humic acid whilst the part insoluble in alkalies consists essentially of carbon; and that Molisch had shown earlier that the black contents arise by a process of humification from a gum present in the cell lumen.

Trees with Very Soft Woods.—The giant stinging tree (*Laportea gigas*), glossy-leaved stinging tree (*Laportea photiniphylla*), flame tree (*Brachychiton acerifolium*), scrub bottle (*Brachychiton discolor*) and the Queensland bottle tree (*Brachychiton rupestre*), which is sometimes found in the light rain forests, have very soft, porous woods. The woods of *Panax elegans* and *P. Murrayi* are also soft, but not to the same degree as those of the stinging trees.

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[7] Solereder, "Systematic Anatomy of the Dicotyledons," trans. Boodle and Fritsch, revised D. H. Scott, Vol. I, p. 518 (1908).

Trees with Woods Depositing Brightly-coloured Ashes.—A limited number of rain-forest trees, when burnt, deposit coloured ashes which are noticeable in newly burnt felled "scrub." Among the most conspicuous examples are the bonewood, pink-heart or native orange (*Medicosma Cunninghamii*), which deposits a bright blue ash, and the ironwood (*Myrtus Hillii*), which deposits a bright yellow ash. The bonewood, which rarely exceeds a barrel diameter of 9 inches, owes its common name to the brittleness of the wood which is brought under the notice of axemen by the circumstance that the first blow with the blade of the axe often detaches a large flake of the bark and wood. The name pink-heart originates from the bright pink central heartwood which often traverses the barrel.

Trees with Coloured Woods.—A very large number of trees have coloured woods, but only a few of the more distinctive ones can be mentioned here. The deep yellow-wood (*Rhodosphaera rhodanthema*) has a bright yellow heartwood. The wood of yellow sassafras (*Doryphora sassafras*) is also bright yellow. The black bean (*Castanospermum australe*), lignum-vitæ (*Vitex lignum-vitæ*), and hauer (*Dissiliaria baloghioides*) have dark-coloured heartwoods which generally fade to a lighter colour after a few weeks' exposure. The tulip wood (*Harpullia pendula*) has dark streaks in its heartwood. Trees with red woods are numerous; among the more common are red cedar (*Cedrela toona* var. *australis*), rosewood (*Dysoxylon Fraseranum*), scentless rosewood (*Synoum glandulosum*), maiden's blush (*Sloanea australis*), red ash (*Alphitonia excelsa*), onion-wood (*Dysoxylon* sp.), red bean (*Dysoxylon* sp.) and crow's apple (*Owenia venosa*).

The Large Medullary Rays of Proteaceæ.—It is well known to wood technologists and others that large and conspicuous medullary rays are very often chareteristic of the woods of many species of the natural order *Proteaceæ*, such as the silky oaks and beefwoods (*Grevillea* spp., *Macadamia* spp., *Orites excelsa, Cardwellia sublimis, Stenocarpus* spp.). The ends of these large rays are visible as small more or less elliptical spots on the surface of the sapwood when the bark is removed. The "soft tissue" or wood parenchyma of Proteaceous timbers is very frequently arranged in short lines transverse to the medullary rays.

Trees Exuding Latex.—A number of trees exude a milky juice or latex when the bark, sapwood, or succulent parts is cut or ruptured. This group includes the majority of the Queensland species of the natural order *Sapotaceæ,* comprising the genera *Sideroxylon, Chrysophyllum, Lucuma, Hormogyne* and *Mimusops*; many species of the natural order *Urticaceæ* such as the species of fig trees (*Ficus*) and the axe-handle-wood (*Pseudomorus Brunoniana*); several species of the natural order *Euphorbiaceæ* such as the scrub poison tree (*Excæcaria Dallachyana*) and the majority of the species of the natural order *Apocynaceæ* such as *Alstonia* spp. including the native quinine tree (*Alstonia constricta*) and the milky pine (*A. scholaris*), *Cerbera odollam* and *Ochrosia* spp. Among the species of figs, *Ficus stenocarpa* is exceptional, as its juice is not milky. The flow of latex from species of *Ficus* and *Excæcaria* is generally copious.

Trees Whose Sap or Woody Parts Change Colour on Exposure.—The scrub bloodwood (*Baloghia lucida*), a tree rarely exceeding 1 foot in barrel diameter, has a bark more or less stained by a reddish brown sap which is frequently transformed into scattered hardened spots or nodules giving the bark a rather rough appearance. When the bark is freshly cut the sap appears colourless and turns bright red after a few seconds' exposure to the air. The native olive (*Olea paniculata*) attains about 1 foot 8 inches in barrel diameter in South Queensland rain forests. The barrel is sometimes flanged at the base and the bark on large trees slightly fissured or wrinkled with small warts arranged in longitudinal lines or rows in the wrinkles or shallow fissures. The bark and sapwood when freshly cut are white or pale, but turn pink after being exposed to the air for ten or fifteen minutes.

Trees Whose Freshly Cut Bark and Sapwood have a Characteristic Odour.—The mango bark (*Bursera australasica*) possesses an odour of mangoes in its freshly cut bark and sapwood. The sassafrases (*Cinnamomum Oliveri, Doryphora sassafras,* and *Daphnandra aromatica*) have a strong smell of sassafras. Native cascarilla (*Croton insularis*) has an odour like that of official cascarilla bark (*Croton Eleuteria*). Red cedar (*Cedrela toona* var. *australis*), rosewood (*Dysoxylon Fraseranum*) and incense wood (*Amoora nitidula*) have an aroma like that of the cedar oil used for oil immersion lenses, the aroma being present in the timbers, too. Some species of *Dysoxylon* have a disagreeable odour like that of onions and are, accordingly, sometimes called "onionwood" by bushmen. The turnip-wood (*Akania Hillii*) has a strong odour of turnips. *Panax elegans,* sometimes known as celery-wood, has a faint smell of celery. Black bean (*Castanospermum australe*) has a pumpkin or cucumber-like smell. Species of the natural order *Laurineæ* generally possess more or less fragrant barks. The aroma of the bark and wood of red cedar is often noticeable in the crushed green leaves, and is sometimes a useful means of identifying them.

Trees with Deciduous Leaves.—The majority of Queensland rain-forest trees is evergreen. The following species, however, are deciduous:—red cedar, white cedar, (*Melia Azedarach*), and *Ficus Cunninghamii.* The koda (*Ehretia acuminata*), *Ficus gracilipes*, flame tree (*Brachychiton acerifolium*), scrub bottle tree (*Brachychiton discolor*), Burdekin plum (*Pleiogynium Solandri*), and the Mackay cedar (*Albizzia toona*) are partly, if not truly, deciduous, and are often seen with very young leaves in the spring or early summer months—September, October, or November.

Trees with Leaves which Turn a Brilliant Red Colour in Age.—The leaves of the quandong (*Elæocarpus grandis*) and the mountain beech (*Elæocarpus Kirtonii*) turn a brilliant red colour in age. They are often conspicuous on the trees and on the ground beneath. Another species, the so-called native "bleeding heart" (*Homalanthus populifolius*), which rarely attains the size of a timber tree and is more commonly seen as a shrub, has leaves which turn a deep red colour when old.

ACKNOWLEDGMENTS.

The writer is indebted to the Commonwealth Meteorologist's (Mr. Hunt's) work "Rainfall Observations in Queensland" for the rainfall data contained in the paper.

THE

ROYAL SOCIETY OF QUEENSLAND.

ABSTRACT OF PROCEEDINGS.

REPORT OF COUNCIL FOR 1921.

To the Members of the Royal Society of Queensland.

Your Council has pleasure in submitting its Report for 1921.

During the year ten papers were read before the Society and published. In addition, the following lectures, to which the public were invited, were delivered:—"Glacial Man," by Prof. S. B. J. Skertchly, a past President of the Society; "The Aborigines of Central Australia," Captain S. A. White; "Plant Distribution in the United States," Prof. D. H. Campbell; "The Relation of the Oil Fields of the World to the Continental Shelves of the Archæan Continents," Dr. H. I. Jensen; "Australian Marsupials," Prof. W. K. Gregory. The attendance in each case was very gratifying.

As in previous years the Queensland Government voted £50 to the Society for the publication of scientific papers, and acknowledgment of this practical assistance is hereby made. We also wish to acknowledge subsidies by the Trustees of the Walter and Eliza Hall Fund towards defraying the cost of the following papers by Prof. T. H. Johnston and O. W. Tiegs, M.Sc. (Walter and Eliza Hall Fellow in Economic Biology):—"New and Little-known Sarcophagid Flies from South-Eastern Queensland" and "On the Biology and Economic Significance of the Chalcid Parasites of Australian Sheep Maggot-flies." The cost of publishing the paper by Prof. T. H. Johnston and Miss M. J. Bancroft, B.Sc. (late Walter and Eliza Hall Fellow in Economic Biology), entitled "The Freshwater Fish Epidemics in Queensland Rivers," was also borne by the Trustees of the Walter and Eliza Hall Fund.

During the year there have been eleven meetings of the Council, the attendances being as follows:—C. T. White

(President) 8, E. W. Bick 9, W. H. Bryan 7, B. Dunstan 3, W. D. Francis 10, E. H. Gurney 4, T. H. Johnston 8, H. A. Longman 9, H. J. Priestley 7, H. C. Richards 10, J. Shirley 10, F B. Smith 3.

The roll of members consists of ten corresponding and ninety-two ordinary members and three associates. Three resignations were accepted.

With deep regret we record the death of Dr. R. L. Jack, one of our life members, and formerly Government Geologist of Queensland. The late Dr. Jack distinguished himself in geological research in Queensland, in which he was a pioneer, and in Great Britain before the inception of his notable work in this State.

Our thanks are tendered to the University of Queensland for affording accommodation for meetings and for housing the library.

In September, 1921, the Council was unfortunately obliged to discontinue the publication of papers on account of lack of funds, and for that reason several papers handed into the Society could not be published at that time. At a later date the financial position improved owing to the receipt of delayed subscriptions.

A special effort has been made to place the finances of the Society on a satisfactory footing, with the result that after meeting all outstanding liabilities there is a balance of £35 5s. 7d. in hand.

C. T. WHITE, *President.*

W. D. FRANCIS, *Hon. Secretary.*

THE ROYAL SOCIETY OF QUEENSLAND.

Cr. BALANCE-SHEET FOR YEAR ENDED 31st DECEMBER, 1921. Dr.

Expenditure.	£	s.	d.
Printing (Pole and Co.)	111	4	0
Printing (Government Printer)	164	0	6
Hon. Secretary	11	0	0
Hon. Treasurer	2	12	6
Insurance	0	18	0
Cost of Public Meeting (National Park)	2	0	0
Expenses of Lecturer	3	0	0
Dishonoured Cheque	2	11	0
Bank Charge	0	10	0
Cheque Book	0	5	0
Exchange	0	4	2
Bank Balance	35	5	7
	£333	10	9

Receipts.	£	s.	d.
By Bank Balance	101	10	8
Subscriptions	103	0	9
Payments for Authors' Copies and Illustrations	71	16	9
Government Subsidy	50	0	0
Refund of Unexpended Grant	2	0	0
Sale of Proceedings	1	0	0
Discount (Pole and Co.)	2	15	1
Council Levy	1	7	6
	£333	10	9

Examined and found correct.

H. J. PRIESTLEY,
Hon. Auditor.

JOHN SHIRLEY, Hon. Treasurer.

1st March, 1922.

Abstract of Proceedings, 11th April, 1922.

The Annual General Meeting of the Society was held in the Geology Lecture Theatre of the University at 8 p.m. on 11th April, 1922. His Excellency Sir Matthew Nathan, G.C.M.G., the Patron, was in the chair.

It was moved by Prof. T. H. Johnston, seconded by Prof. H. C. Richards, and carried unanimously, that the action of the Council in postponing the Annual Meeting from March be confirmed.

His Excellency referred in highly appreciative terms to the work of the late Dr. Shirley, and proposed that a letter of condolence be forwarded to Mrs. Shirley. The motion was seconded by Mr. H. A. Longman, supported by Prof. Skertchly, and carried unanimously.

The minutes of the last Annual General Meeting were read and confirmed.

The Annual Report and Financial Statement were adopted on the motion of Mr. J. B. Henderson, seconded by Mr. E. H. Gurney.

Dr. A. J. Sawyer was elected as an Ordinary Member of the Society.

The following officers were elected for 1922:—

President: Professor H. J. Priestley, M.A.

Vice-Presidents: C. T. White, F.L.S. (*ex officio*); Dr. E. O. Marks, B.A., B.E.

Hon. Secretary: W. D. Francis.

Hon. Editor: H. A. Longman, F.L.S.

Hon. Librarian: W. H. Bryan, M.Sc.

Members of Council: E. H. Gurney, Dr. H. I. Jensen, Professor T. H. Johnston, Professor H. C. Richards, and E. H. F. Swain.

It was proposed by Prof. Johnston, seconded by Mr. Longman, and carried, that Mr. E. W. Bick be appointed Acting Honorary Treasurer.

Mr. H. A. Longman, F.L.S., exhibited a live specimen of the "Ribbon-tailed Gecko" (*Diplodactylus tænicauda* De Vis), which had been donated to the Queensland Museum by Mr. E. S. Barton, of Mount Darry, *viâ* Toowoomba. The ribbon-like streak of tawny colour on the tail is a remarkable feature of this lizard.

Prof. T. H. Johnston, M.A., D.Sc., exhibited specimens of *Opuntia monocantha* which were destroyed or in process of being destroyed by the so-called "Wild Cochineal Insect" (*Coccus indicus*), the progeny of material forwarded by the Prickly-pear Travelling Commission (consisting of Mr. H. Tryon and himself). The original material was collected in India and Ceylon, whence it was sent to Queensland early in 1913. This particular species of insect is responsible for the annihilation of *Opuntia monocantha* from Queensland.

Messrs. S. R. L. Shepherd, L. F. Hitchcock, and G. H. Hardy were proposed for ordinary membership.

The retiring President, Mr. C. T. White, F.L.S., delivered his address, entitled "A Contribution to our Knowledge of the Flora of Papua (British New Guinea)."

A vote of thanks to the lecturer was proposed by Prof. Johnston, seconded by Mr. Tryon, supported by Prof. Skertchly, and carried unanimously.

A Paper by the late Dr. Shirley, entitled "Marine Mollusca from New Guinea," was tabled and taken as read.

Professor Richards, seconded by Mr. Longman, moved a vote of thanks to His Excellency for presiding.

Abstract of Proceedings, 31st May, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University at 8 p.m. on Wednesday, 31st May, 1922.

The President, Prof. H. J. Priestley, M.A., in the chair.

The minutes of the previous monthly meeting were read and confirmed.

Mr. J. S. Just was unanimously elected as an ordinary member.

Drs. J. V. Duhig and A. H. Marks were proposed for ordinary membership.

Mr. W. H. Bryan, M.Sc., exhibited a fine specimen of a large ammonite from the Walsh River, showing cavities filled with calcite and quartz crystals, which had been presented to the Queensland Museum by Mr. J. Clark. Mr. Bryan identified the fossil as *Crioceras plectroides*, Eth.

Mr. C. T. White, F.L.S., exhibited (1) specimens of *Bambusa Moreheadiana*, Bail., a common climber in the scrubs (rain forests) of the Russell River area (bamboos are tropical plants which reach their greatest development in Southern and Eastern Asia. The group is represented in Australia by only two species); (2) fruits of *Garcinia Xanthochymus*, Hook. f., a native of India, cultivated in North Queensland; the specimens were gathered by Mr. W. J. Ross from a tree growing at Edge Hill, near Cairns; (3) resin exuded by *Calophyllum Inophyllum*, Linn., collected on Daru Island by Mr. J. Cowling.

Mr. H. A. Longman, F.L.S., exhibited a mounted specimen of an unusually large bandicoot recently killed in Brisbane and donated to the Queensland Museum. He suggested that the large bandicoots occasionally found in South Queensland were the result of the ample diet provided by the introduction of sweet potatoes. In view of variations associated with growth, especially in the mandible, he thought that the supposed specific distinctions between the Northern bandicoots, *Isoodon macrurus* and *torosus* and the Southern *I. obesulus* should be maintained only as subspecies, especially as some of the South Queensland specimens had the characteristics of the Northern form. Mr. Longman also exhibited a fossil fragment of a reptilian mandible, articular portion, found in the Rewan Police Paddock, Rolleston district, given to him by Dr. Jensen. Although too incomplete to be further determined, the fragment presented characteristics unknown in any fossil or existing Australian reptile.

Dr. H. I. Jensen, in communicating his paper entitled "Some Notes on the Geology of Northern Australia," delivered a lecture on the geology of that part of the continent. He explained how the swing of the trend lines of the folded Silurian and Devonian rocks implied the geographical unity of North-West Queensland, the Northern Territory, and the West Australian massif as far back as the Precambrian; the Palæozoic sediments were moulded upon the old continent and increased its area in an easterly direction. The undisturbed nature of the Permo-Carboniferous in North Queensland shows that the whole of the North of this State became part of the Gondwana continental mass in late Palæozoic times, the Permo-Carboniferous sediments being left by what Suess calls a transgression.

But the major portion of Eastern Queensland was a geosynclinal not only in Palæozoic times but also through most of the Mesozoic era. Folding movements in South-Eastern Queensland have lasted even to the Tertiary. Prof. Richards Mr. W. H. Bryan, and Dr. E. O. Marks took part in the subsequent discussion.

Abstract of Proceedings, 26th June, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 26th June, 1922.

The President, Prof. H. J. Priestley, M.A., in the chair.

The minutes of the previous monthly meeting were read and confirmed.

Mr. J. C. McMinn was proposed for ordinary membership.

Drs. J. V. Duhig and A. H. Marks were unanimously elected as ordinary members.

Mr. C. T. White, F.L.S., pointed out the desirability of establishing an arboretum at Victoria Park, and moved that the Secretary be instructed to write to the City Council and suggest that a project with this end in view be inaugurated. The motion was seconded by Mr. E. W. Bick, supported by Prof. H. C. Richards, D.Sc., and carried unanimously.

On behalf of Mr. H. A. Longman, Dr. E. O. Marks, B.A., B.E., exhibited a piece of sandstone from Adavale showing obscure markings like impressions of the foot of a kangaroo. Dr. Marks also exhibited a specimen of slag from Mount Morgan.

Mr. W. H. Bryan, M.Sc., exhibited an excellent specimen of foraminiferal limestone purchased by Miss C. Moxon in Cairns. The polished faces showed well-preserved sections of *Fusulina japonica*, which is the most characteristic carboniferous foraminifer of Eastern Asia.

In communicating his paper entitled, "The Geology and Petrology of the Enoggera Granite and Allied Intrusives, Part II., Petrology," Mr. Bryan gave a general account of the series of granitic rocks lying on the western outskirts of Brisbane. After discussing the place of these rocks in the geological history of Southern Queensland, and showing that they could be closely correlated with the granites of the Stanthorpe and New England Districts, he described some of the more prominent of the many varied rock types to be met with in the area. Prof. Richards, Dr. E. O. Marks, Messrs. Bennett, Gurney, and White took part in the subsequent discussion.

Abstract of Proceedings, 31st July, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 31st July, 1922.

His Excellency the Governor, Sir Matthew Nathan, P.C., G.C.M.G., attended by Captain Hammond, A.D.C., was present and presided over a crowded audience.

The minutes of the previous meeting were taken as read.

Mr. J. C. McMinn was unanimously elected to ordinary membership.

Professor H. C. Richards, D.Sc., then gave an address on "Kosciusko: The Roof of Australia," in which the parts played by Strzelecki, W. B. Clarke, Von Lendenfeld, Helms and David in elucidating the geological and glacial history were pointed out; also the more recent work of E. C. Andrews and Griffith Taylor, and its significance, was indicated. The geological history of the Kosciusko mass, especially in its relationship to the surrounding country, was considered; also the glaciation to which the area has been subjected. By means of lantern slides and blackboard diagrams the topography and glacial features were illustrated.

On the motion of Dr. H. I. Jensen and Mr. A. J. Thynne, supported by His Excellency the Governor, a vote of thanks was extended to the lecturer.

Abstract of Proceedings, 31st August, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University at 8 p.m. on Thursday, 31st August, 1922.

The President, Professor H. J. Priestley, M.A., in the chair.

The minutes of the previous monthly meeting were read and confirmed.

Mr. P. A. L. Dunne, who was a member of the party which established the cyclone-warning station on Willis Island, exhibited a large number of specimens, including shells and corals collected during his visit, and gave a general account of conditions on the island. Professor Richards commented on Mr. Dunne's exhibit.

Professor H. C. Richards, D.Sc., read a paper entitled "Anorthoclase Basalt from Mapleton, Blackall Range, South-eastern Queensland." The rock described is the first basic alkaline lava containing anorthoclase described from Queensland. It occurs near the head of the Mapleton Falls, 2 miles south-west of Mapleton. The flow has abundant lozenge-shaped phenocrysts of anorthoclase, and rests on top of an olivine basalt. It is Upper Cainozoic in age, and is the concluding effusion of the most recent volcanic activity. Chemically it differs from the normal basalts forming the Blackall Range in having lower alumina, more iron oxides, less magnesia, considerably less lime, more soda, and twice as much potash. It has chemical characters similar to those of an oligoclase basalt from Spicer's Peak, Main Range, and of a basalt from Mount Lindsay, Macpherson Range. The Spicer's Peak basalt is the concluding effusion of the Upper Cainozoic activity, and the Mount Lindsay basalt of the Lower Cainozoic activity. The similarity of these concluding flows and their departure from the normal seem to be more than a coincidence. Dr. E. O. Marks and Mr. J. H. Reid discussed the paper.

Mr. J. H. Reid read a paper entitled "A Note on the Walloon Jurassic Flora." The author concludes:—(1) That *Thinnfeldia*, the predominant genus of the Ipswich beds, appears to be practically, if not absolutely, absent from the Walloon in the Moreton and Roma Districts; (2) that the large-leaved *Tæniopteridæ*, as well as *T. Tenison-Woodsi* and *T. Dunstani*, similarly do not ascend into the

Walloon as far as we know, this genus being only represented (though in great abundance) so far by *T. spatulata;* (3) that *Cladophlebis australis* is predominant in the Walloon. Professor Richards, Dr. Marks, and Mr. Bryan discussed the paper.

A paper by Mrs. B. B. Grey, F.L.S., entitled "Notes on Species of Sagitta Collected during a Voyage from England to Australia," was tabled and taken as read.

Abstract of Proceedings, 26th September, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University at 8 p.m. on Tuesday, 26th September, 1922.

The President, Prof. H. J. Priestley, M.A., in the chair.

The minutes of the previous monthly meeting were read and confirmed.

The following papers were tabled and taken as read:—

By Prof. T. H. Johnston, M.A., D.Sc., and O. W. Tiegs, M.Sc.: "New and Known Sarcophagid Flies." In this paper two new species are described, and a new genus proposed for the reception of a previously-named species. Additional locality records are given for many other species belonging to this family of blowflies.

By Prof. T. N. Johnston and G. H. Hardy: "A Synonymic List of Some Described Australian Calliphorine Flies." The paper records the results of an attempt to elucidate the abundant synonymy which exists in regard to the commonest Australian Calliphorine blowflies.

Mr. H. A. Longman, F.L.S., exhibited (1) the skin and skull of an albino wallaby, *Macropus dorsalis,* donated to the Queensland Museum by Mr. R. D. Wearne, Biggenden; (2) a very large cuttle bone collected by himself on Stradbroke Island, the dimensions of which were: Maximum length (not quite complete), 487 mm.; maximum breadth (incomplete), 158 mm. The specimen was compared with Pilsbry's *Sepia hercules,* but probably represents a distinct species.

Mr. C. T. White, F.L.S., delivered a lecture entitled "The Eucalypts of the Brisbane District." He stated that the Eucalypts were distinctly Australian trees. Although a few North Australian species spread to New Guinea, Timor, and the Philippine Islands, there was no country other than Australia with endemic species of the genus. The genus Eucalyptus probably contains about 350 species. Of these, between seventy and eighty occur in Queensland, and twenty-one species are to be found growing within about a 10-mile radius of the City of Brisbane. The species occurring about Brisbane can be classified for practical purposes into five groups: (1) Gums proper or smooth-barked trees, six species, *Eucalyptus hæmastoma* var. *micrantha* (Scribbly Gum), *E. tereticornis* (Blue Gum), *E. propinqua* (Grey Gum), *E. Seeana* (Narrow-leaved Blue Gum), *E. maculata* (Spotted Gum), and *E. saligna* (Flooded Gum); (2) the stringybarks and mahoganies, seven species, *E. acmenioides* (Yellow Stringybark), *E. acmenioides* var. *carnea* (Yellow Stringybark), *E. umbra*, *E. eugenioides* (White Stringybark), *E. resinifera* (Red Stringybark), *E. Baileyana*, *E. Planchoniana* and *E. Microcorys* (Tallow-wood); (3) the ironbarks, four species, *E. paniculata* (Grey Ironbark), *E. crebra* (Narrow-leaved Ironbark), *E. siderophloia* (Broad-leaved Ironbark), and *E. melanophloia* (Silver-leaved Ironbark); (4) the boxes, one species, *E. hemiphloia* (Gum-topped Box); and (5) the Bloodwoods, three species, *E. corymbosa* (Red Bloodwood), *E. trachyphloia* (White Bloodwood) and *E. tesselaris* (Moreton Bay Ash). A vote of thanks was accorded the lecturer on the motion of Prof. Richards, seconded by Dr. E. O. Marks, and supported by Prof. Johnston and Messrs. Longman, Swanwick, and Bennett.

Abstract of Proceedings, 30th October, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in the Geology Lecture Theatre of the University at 8 p.m. on Monday, 30th October, 1922.

The President, Prof. H. J. Priestley, M.A., in the chair.

The minutes of the previous monthly meeting were read and confirmed.

Mr. H. A. Longman, F.L.S., exhibited a single large fossil vertebra recently found near Dalby by Mr. Thos. Jack, who donated it to the Queensland Museum. He identified it as one of the caudals of *Megalania prisca,* an ally of the monitor lizards or "goannas" of to-day, but which was about 18 feet in length.

Mr. W. H. Bryan, M.Sc., exhibited a fossil specimen of a species of the class Equisetales which was found in the Brisbane tuff at Morningside by Miss Moxon.

Prof. H. C. Richards, D.Sc., read a paper entitled, "An Unusual Rhyolite from the Blackall Range." The rhyolite, which is at least 1,000 feet thick, forms the Bon Accord Falls in Skene's Creek and the Narrows in the Obi Obi Creek. Chemically the rock is very remarkable, and a comparison with other analyses shows that it is one of the most acid lavas yet recorded. Its high silica content of over 85 per cent., together with its low alumina content of about 5½ per cent., show its remarkable chemical characters. It is believed that heated waters containing silica, carbonic acid gas, &c., have been responsible for the alteration of the original rhyolite, and that these waters are of magmatic origin, and acted during the last stages of cooling down of the lava. The term deuteric has been given to these reactions by Sederholm, and they are believed to be much more common than hitherto understood.

Messrs. W. H. Bryan, E. H. Gurney, F. Bennett, and Dr. E. O. Marks took part in the subsequent discussion.

Abstract of Proceedings, 24th November, 1922.

The Ordinary Monthly Meeting of the Royal Society of Queensland was held in conjunction with that of the Royal Geographical Society of Australasia (Queensland) in the Geology Lecture Theatre of the University at 8 p.m. on Friday, 24th November, 1922.

His Excellency Sir Matthew Nathan, P.C., G.C.M.G., presided.

The minutes of the last meeting were taken as read.

Sir Matthew Nathan and Professor H. J. Priestley referred appreciatively to the scientific work of Professor

T. H. Johnston and to his active interest in the Royal Society and the Royal Geographical Society, and deeply regretted his departure from the State.

Drs. R. W. Cilento and S. Fancourt McDonald were nominated for ordinary membership.

Professor F. Wood-Jones, D.Sc., M.B., B.S., delivered a lecture on "Corals," giving a lucid exposition of his researches at the Cocos-Keeling atoll.

A vote of thanks to the lecturer was proposed by Prof. Richards, seconded by Prof. Johnston, supported by His Excellency, and carried by acclamation. Reference was made to the important work to be undertaken by the Barrier Reef Research Committee, and the hope was expressed that Prof. Wood-Jones would be able to take an active part in some phase of its activities.

A paper by Mr. W. D. Francis, entitled "Some Characteristics of Queensland Rain Forests and Rain-Forest Trees," was tabled and taken as read.

Publications have been received from the following Institutions, Societies, etc. and are hereby gratefully acknowledged.

AFRICA.

Durban Museum, Durban.

AMERICA.

BRAZIL—

Instituto Oswaldo Cruz, Rio Janeiro.

CANADA—

Department of Mines, Ottawa.
Royal Canadian Institute, Toronto.
Royal Astronomical Society of Canada, Toronto.
Royal Society of Canada, Ottawa.

UNITED STATES—

American Academy of Arts and Sciences, Boston.
American Geographical Society, New York.
Academy of Natural Science, Philadelphia.
American Philosophical Society, Philadelphia.
Californian Academy of Science, San Francisco.
Indiana Academy of Science.
Rochester Academy of Science.
National Academy of Science and Smithsonian Institute, Washington.
Library of Congress.
American Museum of Natural History, New York City.
New York Zoological Society, New York.
Department of Agriculture.
Arnold Arboretum.
Department of Commerce, New York.
Missouri Botanic Gardens, St. Louis, Missouri.
University of California, Berkeley.
University of Colorado.
Cornell University.
John Hopkins University.
University of Illinois, Urbana.
Ohio State University.
University of Kansas, Lawrence.
University of Minnesota, Minneopolis.
Oberlin College.
National Research Council.
Buffalo Society of Natural Science.
Portland Society of Natural History.
Lloyd Library.
Bernice Pauahi Bishop, Museum, Honolulu, Hawaiian Islands.

MEXICO—

Instituto Geologico de Mexico, Mexico.
Sociedad Cientifica, Mexico.

ASIA.

INDIA—

Colombo Museum, Colombo, Ceylon.
Agricultural Institute, Pusa, Bengal.
Geological Survey of India.
Superintendent, Government Printing.
Survey of India, Dehra Dun.

JAVA—

Department van Landbrouw, Batavia.
Koninckllyke Naturkundige, Batavia.

PHILIPPINE ISLANDS—

Bureau of Science, Manila.

AUSTRALIA AND NEW ZEALAND.

QUEENSLAND—

Field Naturalists' Club, Brisbane.
Geological Survey of Queensland, Brisbane.
Queensland Museum, Brisbane.
Government Statistician, Brisbane.

NEW SOUTH WALES—

Australasian Association for the Advancement of Science, Sydney.
Department of Agriculture, New South Wales.
Botanic Gardens, Sydney.
Geological Survey of New South Wales, Sydney.
Public Library, Sydney.
Linnean Society of New South Wales, Sydney.
Australian Museum, Sydney.
Royal Society of New South Wales, Sydney.
Naturalists' Society of New South Wales, Sydney.
University of Sydney.

VICTORIA—

Bureau of Census and Statistics, Melbourne.
Royal Society of Victoria, Melbourne.
Field Naturalists' Club, Melbourne.
Department of Agriculture, Melbourne.
Department of Mines, Melbourne.
Australasian Institute of Mining and Metallurgy, Melbourne.
National Museum, Melbourne.
Institute of Science and Industry, Melbourne.
Scientific Australian.

TASMANIA—

Royal Society of Tasmania, Hobart.
Field Naturalists' Club, Hobart, Tasmania.
Geological Survey of Tasmania.

South Australia—

Royal Society of South Australia, Adelaide.
Royal Geographical Society of South Australia, Adelaide.
National Museum of South Australia, Adelaide.
Geological Survey of South Australia, Adelaide.

West Australia—

Royal Society of West Australia, Perth.
Geological Survey of West Australia, Perth.

New Zealand—

Auckland Institute, Auckland.
New Zealand Board of Science and Art.
Dominion Laboratory, Wellington.
Geological Survey of New Zealand.
New Zealand Institute, Wellington.

EUROPE.

Austria—

Annals Natural History Museum, Vienna.

Belgium—

Academie Royale, Brussels.
Société Royale de Botanique de Belgique.
Société Royale de Zoologique de Belgique.

Czecho-Slovakia—

Spolecnosti Entomologické, Prague.

Great Britain—

Cambridge Philosophical Society.
Conchological Society of Great Britain and Ireland.
Imperial Bureau of Entomology, London.
Literary and Philosophic Society, Manchester.
Royal Society of London.
Royal Botanic Gardens, Kew.
Royal Colonial Institute, London.
Royal Society of Edinburgh.
Botanic Society, Edinburgh.

France—

Société Geologique et Mineralogique de Bretague, Rennes.
Société Botanique de France, Paris.
Musee d'Histoire Naturelle.
Société Scientifique Naturelle, Nantes.
Office Scientifique Peches Maritimes.
Observations Meteorologique de Mont Blanc.

Italy—

Societa Agricana d'Italia, Naples.
Instituto di Bologna.
Societa Toscana di Scienze Naturali, Pisa.

POLAND—

Univesitatis Liberæ Polonæ.

SPAIN—

Real Academia de Ciencias de Madrid.
Real Academia de Ciencias de Barcelona.
Academia de Ciencias de Zaragoza.

SWEDEN—

Geological Institute, Upsala.

SWITZERLAND—

Naturforschende Gesellschaft, Basle.
Naturforschende Gesellschaft, Zurich.
Société de Physique et d'Historie Naturelle, Geneva.
International Labor Office, Geneva.

List of Members.

CORRESPONDING MEMBERS.

‡Danes, Dr. J. V.	Consulate-General for Czecho-Slovakia, Sydney.
David, Professor Sir T. W. E., F.R.S.	The University, Sydney, N.S.W.
‡Domin, Dr. K.	Czech University, Prague, Bohemia.
‡Hedley, C., F.L.S.	Assistant Curator, Australian Museum, Sydney, N.S.W.
Liversidge, Prof. A., F.R.S. ..	Fieldhead, Coombe Warren, Kingston Hill, Surrey, England.
‡Maiden, J. H., I.S.O., F.R.S., F.L.S.	Botanic Gardens, Sydney, N.S.W.
‡Maitland, A. Gibb, F.G.S. ..	Geological Survey Office, Perth, W.A.
Pollock, Prof. J. A., F.R.S. ..	The University, Sydney, N.S.W.
Rennie, Professor E. H. ..	The University, Adelaide, S.A.
‡Skeats, Professor E. W. ..	The University, Melbourne, Vic.

ORDINARY MEMBERS, ETC.

Alexander, W. B., M.A. ..	Prickly-pear Laboratory, Westwood.
Appleby, W. E...	Sugar Refinery, New Farm.
Archer, R. S.	Gracemere, Rockhampton.
Bage, Miss F., M.Sc.	The Women's College, Kangaroo Point, Brisbane.
†Bagster, L. S., D.Sc.	The University, Brisbane.
‡†Bailey, J. F.	Botanic Gardens, Adelaide, S.A.
Ball, L. C., B.E.	Geological Survey Office, George Street, Brisbane.
‡†Bancroft, T. L., M.B.	Eidsvold, Queensland.
‡Bancroft, Miss M. J., B.Sc. ..	Medical School, The University, Sydney.
Barton, E. C., A.M.I.C.E. ..	Boundary Street, Valley, Brisbane.
Berney, F. L.	Barcarolle, *via* Longreach.
‡Bennett, F., B.Sc.	State School, Toowong, Brisbane.
Bick, E. W.	Botanic Gardens, Brisbane.
Bradley, H. Burton, M.B., Ch.M.	Longueville, North Shore, Sydney.
‡Brunnich, J. C., F.I.C... ..	Agricultural Chemist's Lab., William Street, Brisbane.

† Life Members.

‡ Members who have contributed papers to the Society.

‡Bryan, W. H., M.Sc.	The University, Brisbane.
Brydon, Mrs.	Department Public Instruction, Brisbane.
Bundock, C. W., B.A.	"Kooralbyn," Beaudesert.
Butler-Wood, F., D.D.S. ..	Central Chambers, Queen Street, Brisbane.
Butler-Wood, Miss I. V., B.D.S.	Dornoch Terrace, West End.
Cameron, W. E., B.A. ..	Tanbun Road, Ipoh, Perak, Federated Malay States.
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